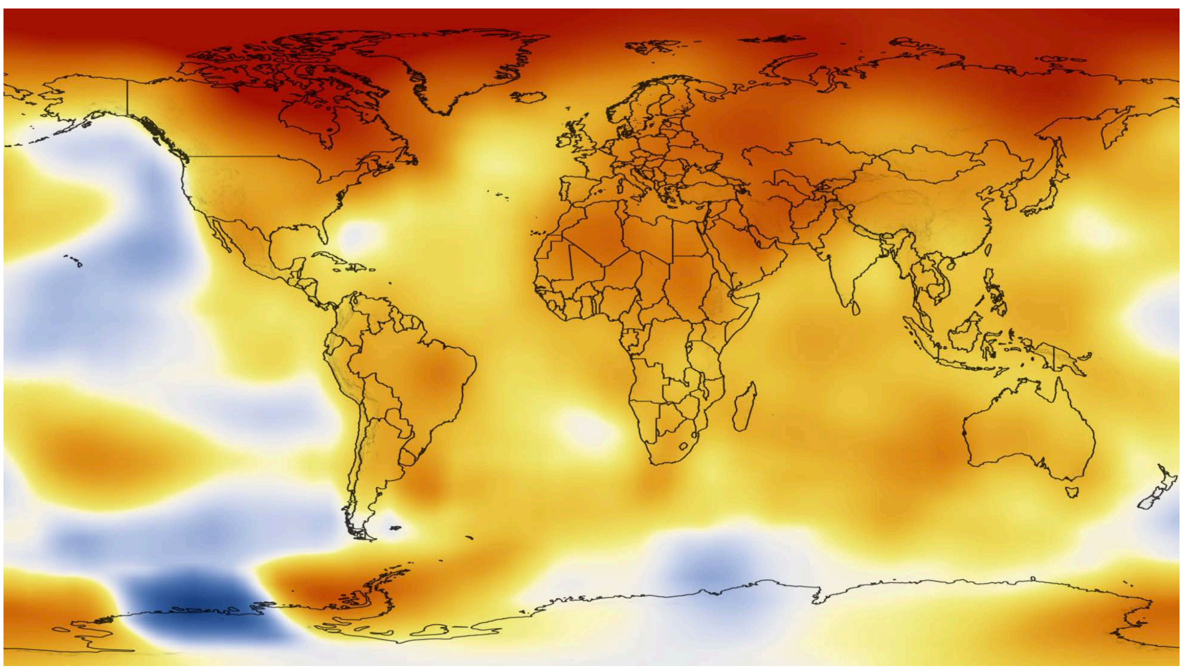
National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Goddard Institute for Space Studies (GISS)
Climate Change Research Initiative (CCRI)
Applied Research STEM Curriculum Portfolio

Unit Title: Wetlands

NASA STEM Educator / Associate Researcher: Carol Wang-Mondaca
NASA PI / Mentor: Dr. Dorothy Peteet
NASA GSFC Office of STEM Engagement –160



I. Executive Summary

Coastal wetlands, like saltmarshes, mangroves, and tidal freshwater wetlands serve a variety of ecosystem and economic services. They have the capacity to be a major sink of greenhouse gases since they store carbon in plant biomass, they are a source of great biodiversity and serve as nurseries to a myriad of birds and other organisms. Wetlands also protect our coasts and serve as natural water filtration systems. They are, however, susceptible to human exploitation. They are threatened by agriculture, drainage, commercial development, and climate change.

This unit has been aligned to NASA's mission to expand our knowledge and scientific understanding of Earth as a system and its response to natural and human-induced changes and to improve our ability to predict climate, weather, and natural hazards. The lessons are intended to provide students with background information on the importance of saltmarshes as an ecosystem, emphasizing the ecosystem services they provide as well as the economic. Literature review is incorporated in order to give students firsthand experience reading, analyzing and presenting actual scientific research. They will then use this research to supplement the CCRI work that our team is conducting. This would then be the impetus to have students create their own methods and protocols to design an experiment so that they can conduct similar research at Alley Pond Saltmarsh. The rationale behind this is so that students have a stake in the process and ownership of the design. Bringing Dr. Peteet in to provide constructive criticism has many benefits, including the opportunity for students to interact with a scientist and also to be able to think at a higher level when challenged with higher expectations. Incorporating a peer review session also teaches students how to provide actionable feedback—traits that prepare them for a leadership role, being college ready and are a reflection of NASA's system engineering behaviors. Finally, the culmination of this unit in conducting hands-on research in the field with impactful data via GLOBE entry is the capstone lesson on the students' adapted version of coring.

II. Introduction Goals and Overview of Unit:

This unit is intended to introduce students to the ecosystem and economic services that wetlands provide. Saltmarshes are essential for coastal protection, water filtration, biodiversity, carbon sequestration, and as nursery habitats for many bird species and fisheries. It is also intended to emphasize how fragile this and other ecosystems are and how human impact has degraded these resources. Saltwater marshes are threatened by upstream pollution and drainage for agriculture, human development, salt extraction and tourism. Students will learn through saltmarsh exploration at Alley Pond Park. They will then investigate human impact, and then through actual in-field, hands on lab work. We will collect soil and water samples at Alley Pond. We will take this even further by incorporating the work done by Dr. Peteet and using those methods in the field, such as coring at the saltmarsh, collecting loss on ignition data as well as collecting foramnifera and macrofossil data to identify the change in flora in the area as well as human impact. Students will conduct their own lab work, after designing their own protocols, complete their research paper and present their findings to their peers. They will then peer review each other's work. Students will have an opportunity to conduct a video conference interview with Dr. Peteet and possibly other NASA scientists.

Students will understand NASA's mission to expand our knowledge of Earth as a system, along with its response to natural and human-induced changes, and to improve our ability to predict climate, weather, and natural hazards.

III. Teacher Biography

Carol Wang-Mondaca currently teaches AP Environmental Science and Science Research at Martin Van Buren High School in Queens, NY. She did not start her career path in teaching, however. Carol was an Editor, Medicine for a large scientific publishing company for many years. Then one day, while riding the subway, she saw an ad that read "Do you remember your third grade teacher's name? Who will remember yours?" That sparked something in her that day and she proceeded to join the NYC Teaching Fellows. While teaching was not her first career, her love for science and investigation has been a constant throughout her life. Carol has been teaching for 15 years, and her goals have always been constant- to inspire our future generation to love and pursue science. She loves working with underrepresented and underserved groups. She very recently was awarded an Earthwatch Kindle Fellowship that allowed her and 7 other NYC public school teachers to go to Little Cayman to study endangered coral reefs. She saw firsthand the result of climate change on the bleaching of coral reefs and the surge in algae that appeared. This trip reignited her passion for research in the field and reinforced her urgency to educate our future minds in climate change. In fact, in the spring of 2019, she took 10 students on a research expedition to the Wrigley Marine Science Center, University of Southern California to participate in studies that look at how climate change has affected marine life along the Catalina coast. By joining the CCRI team on Climate Change in the Hudson Estuary, she is hoping to incorporate NASA resources throughout the year in a new Science Research class that focuses on environmental studies. She is hoping her students can contribute to Dr. Peteet's work on climate change in the Hudson Estuary.

IV. Table of Contents:

V. NASA Education Resources Utilized in Unit

a. Resource Title: Description: Web address

Lesson 1: Importance of wetlands-- background information

(a) NASA on Mangroves Video. NASA's Land Cover and Land Use Change program, Simard and his team have developed new remote sensing techniques to monitor the health of mangrove ecosystems
https://www.youtube.com/watch?time_continue=24&v=RjSTKItUUX0

b) NASA on Saltmarshes. This study demonstrated the ability to identify "hotspots" of early stages of marsh degradation which can only be delineated by evaluating marsh biophysical characteristics
Georgia Ecological Forecasting - NASA DEVELOP Summer 2013 @ University of Georgia
https://youtu.be/pLlu2WiU-z8

c) Featured Phenomenon: Sea Level Change
NASA has been tracking global surface topography of the ciea for more than 20 years. My NASA Data provides maps and data on rising seas by the decade, sea level rise, and a segment on monitoring sea level change.
https://mynasadata.larc.nasa.gov/hydrosphere

d) Map of Life
https://mol.org/

e) Human impact on wetlands: Louisiana case study
(i) Climate change and sea level
https://mynasadata.larc.nasa.gov/hydrosphere
(ii) Wings over Louisiana-- NASA observes land subsidence
https://www.youtube.com/watch?v=1JYVSW1Hydw&t=243s

Lesson 2: Examining a wetland firsthand-Alley Pond Park field trip-- saltmarsh

(a) NatGeo video with Dr. Peteet.
https://www.youtube.com/watch?v=N3P9wch5N3Y

(b) Following GLOBE protocols and uploading water testing data to GLOBE database.
www.globe.gov

Lesson 3: Human impact on the wetlands: literature review

(a) The Vanishing Marshes of Jamaica Bay: Sea Level Rise or Environmental Degradation?
https://www.giss.nasa.gov/research/briefs/hartig_01/

(b) Sediment starvation destroys New York City marshes' resistance to sea level rise
https://blogs.ei.columbia.edu/2018/09/24/urbanization-starving-nyc-wetlands

(c) Uncertainty in United States coastal wetland greenhouse gas inventorying
https://landsat.gsfc.nasa.gov/how-much-swamp-are-we-talking-here-towards-better-mapping-of-coastal-wetlands/
https://iopscience.iop.org/article/10.1088/1748-9326/aae157/pdf

(d) Impacts of sea level rise in the New York City metropolitan area
https://www.giss.nasa.gov/research/briefs/rosenzweig_03/
https://pubs.giss.nasa.gov/abs/go08000d.html

(e) Global Mangrove imaging with Landsat
https://landsat.gsfc.nasa.gov/16367-2/
https://earthobservatory.nasa.gov/images/90309/below-the-mangrove-canopy

Lesson 4: Why preserve Wetlands?

(a) About Dr. Dorothy Peteet
https://www.giss.nasa.gov/staff/dpeteet.html
Investigating Climate Effect on Vegetation and Carbon in Coastal Alaska
https://www.giss.nasa.gov/research/briefs/peteet_04/
An ecosystem feels the human touch
https://www.giss.nasa.gov/research/features/201402_peteet/
Can Global Climate Change Abruptly?
https://www.giss.nasa.gov/research/briefs/peteet_01/

b) Video interview with Dr. Peteet

Lesson 5: Coring at Alley Pond Saltmarsh

(a) The vanishing marshes at Jamaica Bay
https://www.giss.nasa.gov/research/briefs/hartig_01/
https://earthengine.google.com/case_studies/

(b) Tools of the trade: a peek inside the bog-coring lab of Dorothy Peteet https://blogs.ei.columbia.edu/2018/12/19/tools-bog-coring-peteet/
(c) More in-depth water testing with GLOBE

b. Data visualization & analysis activity
Students will perform water quality sampling as well as soil sampling in lesson 2 at Alley Pond Park. They will learn and implement GLOBE protocols and upload their data to GLOBE. In Lesson 5, culminating in the students capstone project, students will be coring and using various depths of the core, determining loss of ignition and foramnifera and macrofossil composition. They will then relate this data collection to determine human impact on the saltmarsh ecosystem. The capstone project will highlight their data collection, analysis and presentation skills. The students must be able to not only present their data but speak to it so that their peers, who have little background knowledge of their research, will be able to understand their findings and significance.

Via globe.gov, students will contribute to the global research data when they upload their data collection, following GLOBE protocols.

c. NASA Mission Alignment
According to NASA's Mission Directorates and Center Alignment, specifically regarding the Earth Science division, its mission is to advance our scientific understanding of Earth as a system and its response to natural and human-induced changes and to improve our ability to predict climate, weather, and natural hazards. This lesson plan unit clearly is aligned to this aspect of NASA'S mission as we investigate wetland ecosystems and how fragile they are in response to climate change. Our hands-on fieldwork to determine loss on ignitionmacrofossil and foranifera profiles of the local saltmarsh at Alley Pond will help us understand how changes have occurred and how the flora have responded.

d. NASA 2018 Strategic Objective Alignment
https://www.nasa.gov/sites/default/files/atoms/files/nasa_2018_strategic_plan.pdf
This unit plan is aligned with NASA's strategic goal 3—to address national challenges and catalyze economic growth. NASA

gathers climate change data and engages and inspires young people to become scientists through this project. Attracting students to enter STEM fields is vitally important and is a component of its strategic goals. Therefore, strategic objective 3.3 sets to inspire, engage and educate and employ the next generation of explorer through NASA-unique STEM learning opportunities. By using NASA resources and drawing on the research of Dr. Peteet, this unit plan would fulfill this objective. This strategic objective includes proactive efforts to diversify the STEM pipeline to NASA internships and employment and increase the number of underrepresented and underserved groups in the STEM fields, including girls in STEM and minority groups.

VI. Research Opportunity Title and Abstract

Coastal Long Island Sound Wetlands: A History of Carbon Storage and Anthropogenic Disturbance Over the Past 800 Years

John Supino[1,4], Carol Wang-Mondaca[2,4], Grant Pace[3,4], Syed Ismail[2,4], Dorothy M. Peteet[4,5]

[1]CUNY—The City College of New York, 160 Convent Avenue, New York, NY, 10031
[2]Martin Van Buren High School, 230-17 Hillside Avenue, Queens Village, NY, 11427
[3]Columbia University, 70 Morningside Drive, New York, NY, 10027
[4]NASA Goddard Institute for Space Studies, New York, NY, 10025
[5]Lamont-Doherty Earth Observatory, 61 Route 9W, Palisades, NY, 10964

Long Island Sound marshes are critical coastal habitats which provide a multitude of ecosystem services, including coastal protection, carbon sequestration, and nursery grounds for many important species. This study examined five sites in three Connecticut watersheds (the Housatonic River, the Quinnipiac River, and the Connecticut River) through loss-on-ignition (LOI), stable isotope ratios, and x-ray fluorescence (XRF) analyses. Inorganic sediments declined, except in cases of human disturbance, and nitrogen percent increased toward the present. Carbon isotope shifts reflect complex changes in plant composition over the past 800 years. Lead and copper increased due to industrialization and then declined after 1974 with the phasing out of leaded gasoline. The results suggest increased erosion of marshes within Long Island Sound, and increased fertilization and heavy metal pollution due to agricultural runoff and human disturbance close by the marsh sites. The study's findings reemphasize the importance of wetlands in carbon storage and their vulnerability to climate change from increasingly dense populations.

VII. Unit Pre-and Post-Standards Based Assessment:

The Wetlands: Pre- and Post-Assessment

The pre and post assessment are based on the Next Generation Science Standards (NGSS) for high school students. The target group for the lesson plans are the Science Research classes, which aims to cultivate students' abilities and knowledge not only in biology and earth science, but also their math, problem solving, and critical thinking skills. The purpose of the pre-assessment is to gauge students' prior knowledge on the subject, especially since the class is comprised of students across all grade levels (9-12). The assessment covers not only content knowledge, but also lab skills since this is a hands-on research unit. The questions are all open-ended so as to give the teacher a better understanding of where the student stands in understanding. This will indicate to the teacher if additional time is required to review background information and review other skills. After teaching the unit, including the capstone, the goal is then that the students will take the same assessment as a post-assessment. This will indicate to the teacher if topics need to be revisited and if students have understood the lessons.

The Wetlands: Baseline assessment (and post-assessment)

Directions: Answer the following questions to the best of your ability.

1. What are wetlands? (5)

2. What are three economic and/or ecological services that wetlands provide? (3 pts each)

3. How have humans impacted wetlands and what are the results? Describe at least 3. (3 pts each)

4. Where can you find saltmarshes in the United States? (5)

5. What is a sediment core? (5)

6. Sketch a graph that best illustrates how lead levels have changed since humans have settled in the Northeast? Explain your answer. (7)

7. On the same graph, do the same for carbon levels and nitrogen levels. Explain your answers. (7)

8. What is eutrophication? (5)

9. What is run off? (5)

10. Why would nitrogen levels increase as human population increases in an area? (8)

11. What is soil organic matter? (5)

12. When conducting an experiment, what is the first step the scientist must take? (5)

13. How do we record our data? (5) How can we organize our data for analysis? (5)

14. List 5 things that we are not allowed to do in the lab. (2 points each)

15. When testing water, what are some characteristics we might want to test for? (Name 3). (5 points)

The Wetlands: Baseline assessment (and post-assessment): ANSWERS
A grade of 58-64 is approaching grade level. A grade of 65-79 is considered at grade level. A grade of at least an 80 is considered mastery.

Directions: Answer the following questions to the best of your ability.

1. What are wetlands? (5 pts)
   Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year

2. What are three economic and/or ecological services that wetlands provide? (3 pts each)

   Wetlands provide habitats for thousands of species of aquatic and terrestrial plants and animals. Wetlands are valuable for flood protection, acting as a buffering system, water quality improvement by filtering the water, shoreline erosion control. Wetlands provide economic services such as natural products, recreation, and aesthetics for humans.

   Wetlands are among the most productive habitats on earth providing shelter and nursery areas for commercially and recreationally important animals like fish and shellfish, as well as wintering grounds for migrating birds. Coastal marshes are particularly valuable for preventing loss of life and property by moderating extreme floods and buffering the land from storms; they also form natural reservoirs and help maintain desirable water quality

3. How have humans impacted wetlands and what are the results? Describe at least 3. (3 each)

   Saltmarsh habitats have been damaged by humans from agricultural draining, oil spills, run off, and pollution. Salt marshes in urban watersheds may receive enormous volumes of stormwater runoff, which can lead to increased erosion, sedimentation, altered salinity levels, and changes in soil saturation levels

   As a result, there is a decrease in biodiversity and ecological services that the saltmarshes can provide. Climate change and sea level rise have also threatened saltmarshes. By building road through saltmarshes, we are also cutting off the water supply from the ocean. Additionally, the introduction of invasive species could potentially alter the native populations of plants and animals.

4. Where can you find saltmarshes in the United States? (5 pts)
   In the US, saltmarshes can be found on every coast. Approximately half the nation's saltmarshes are found along the Gulf Coast. We have one in Alley Pond Park!

5. What is a sediment core? (5 pts)
   A vertical sequence that captures the stratigraphic layers of a sediment with depth while preserving the depositional sequence.

6. Sketch a graph that best illustrates how lead levels have changed since humans have settled in the Northeast? Explain your answer. (7 pts)
   A graph indicating an increase in lead levels from the time of human settlement. A drop of lead in recent years would demonstrate an advanced understanding of using unleaded fuel.

7. On the same graph, do the same for carbon levels and nitrogen levels. Explain your answers. (7 pts)
   A graph indicating an increase in carbon and nitrogen levels from the time of human settlement. The carbon would be a result of manufacturing, release of carbon from storage, and the increase in nitrogen would indicate an increase in fertilizer and run off.

8. What is eutrophication? What results from anthropogenic eutrophication? (5 pts)
   Eutrophication results from and increased load of nutrients to coastal waters and estuaries. This causes harmful algal blooms and low oxygen waters that can kill fish and seagrass and reduced essential fish habitats. The increased load in nutrients (phosphorous and nitrogen) usually comes from agriculture.

9. What is agricultural run off? (5 pts)
   Farmers apply nutrients on their fields in the form of chemical fertilizers and animal manure, which provide crops with the nitrogen and phosphorus necessary to grow and produce the food we eat. However, when nitrogen and phosphorus are not fully utilized by the growing plants, they can be lost from the farm fields. This excess nitrogen and phosphorus can be washed from farm fields and into waterways during rain events and when snow melts, and can also leach through the soil and into groundwater over time.

10. Why would nitrogen levels increase as human population increases in an area? (8 pts)

Nitrogen is found in waste and is also used in agriculture. Therefore, as human population increases, the levels of nitrogen would increase with increased farming to sustain the population and as a result of sewage.

11. What is soil organic matter? (5 pts)
    Soil organic matter is the fraction of soil that consists of plant or animal tissues in various stages of decomposition.

12. When conducting an experiment, what is the first step the scientist must take? (5 pts)
    A scientist must first pose a question.

13. How do we record our data? How can we organize our data for analysis? (5 pts)
    Data is recorded in tables and graphs help us visualize the data for analysis.

14. List 5 things that we are not allowed to do in the lab. (2 pts each)
    We are not allowed to eat, drink, chew gum, wear open toed shoes, wear shorts or short skirts, leave long hair undone, go without a lab coat, leave unlabeled bottles/flasks/beakers/containers laying around, taste or drink any chemicals and reagents.

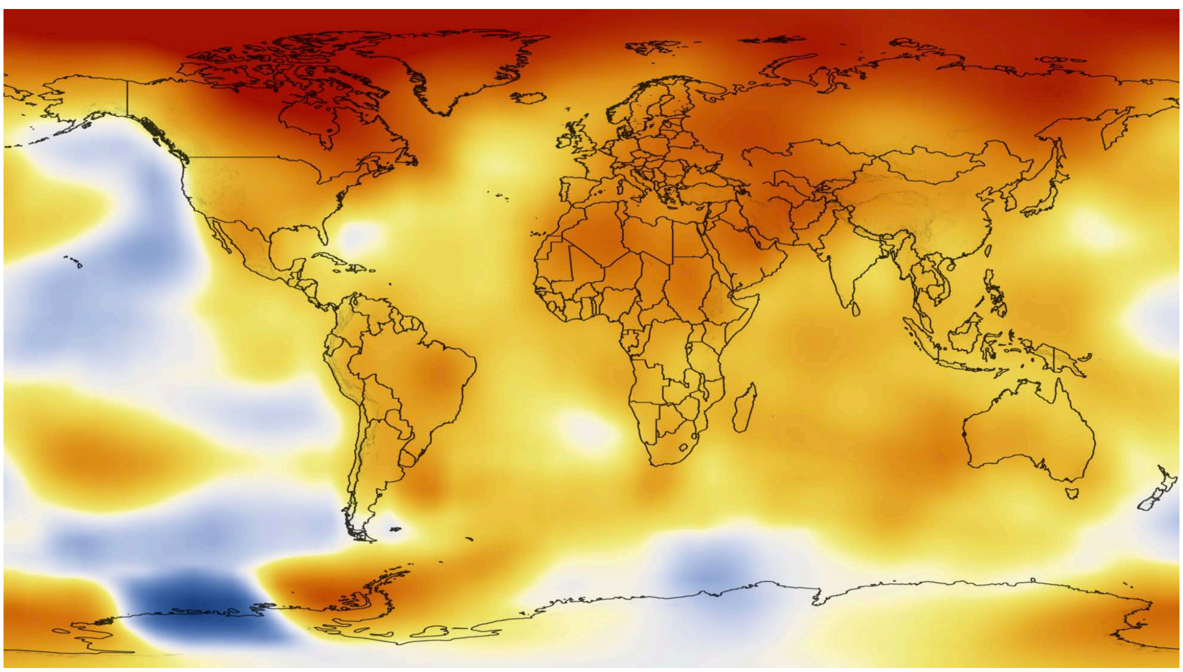
15. When testing water quality, what are some characteristics we might want to test for? (Name 3) (5 pts)
    When testing for water quality, we can test for pH, clarity, salinity, temperature.

National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Goddard Institute for Space Studies (GISS)
Climate Change Research Initiative (CCRI)
Applied Research STEM Curriculum Portfolio

Unit Title: Wetlands

Lesson Title: How are wetlands essential in the ecosystem and economic services they provide?
NASA STEM Educator / Associate Researcher: Carol Wang-Mondaca
NASA PI / Mentor: Dr. Dorothy Peteet
NASA GSFC Office of STEM Engagement –160



VIII. Lesson 1: Why are wetlands essential in their ecosystem and economic services?

a. Summary and Goals of Lesson

This lesson will introduce students to wetlands, including how they are defined and the different types of wetlands that exist. Students will begin to have an understanding of the ecosystem and economic services that wetlands provide.

Students will understand the impact humans have had on the wetland ecosystems. We will use Louisiana as a case study, using NASA's observation of land subsidence information. Students will also use Google Earth Engine case studies to observe the results of climate change on sea level rise and the subsequent impact on marshes and mangroves.

b. Table of Contents for lesson

Lesson Title: Why are wetlands essential in the ecosystem and economic services they provide?
Grade Level: 11th and 12th graders
Duration: 2 days

	What the Teacher Does	What the Students Do	Duration

Engage: **pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.**	Show students pictures of Alley Pond Park. Explain that this is a wetland, right in their own backyards. Using the illustrations, elicit characteristics of wetlands that students can then use to define what wetlands are.	Have students define what they think wetlands are.	15 mins
Explore: **The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.**	Present the different types of wetlands. Explain the commonalities among them as well as their differences.	Students watch the NASA videos on Mangroves and Saltmarshes (within PPT), jotting down the specific characteristics, comparing and contrasting them both	30 minutes
Explain: **Provide students with an opportunity to communicate what they have learned so far and figure out what it means. EXPLAIN**	Allow students to assemble in groups to discuss the characteristics of wetland ecosystems. They are also instructed to discuss possible ways in which these features make them susceptible to human exploitation and how humans might have impacted these ecosystems	Students explain how wetlands have very distinct ecosystem features and services and explain the economic services they provide as well. Students also explain how humans have impacted the environment and the consequences resulting from such impact.	30

Elaborate / Extend: **Allow students to use their new knowledge and continue to explore its implications.**	Explain to students that when we study wetlands, it is difficult to avoid discussing human impact simultaneously. Students remain in groups for further discussion. What characteristics of wetlands make them susceptible to exploitation? Emphasize biodiversity and species richness	What can be done to alleviate the human impact on ecosystems? HANDOUT: Why are wetlands essentials and what economic/ ecosystem services do they provide? HW- using the map of life website, students select three wetlands species and map out their species richness and level of endangerment. (activity guide available)	30
Evaluate: **Both students and teachers to determine how much learning and understanding has taken place.**	Provide exit slip to determine if students can outline the major economic and ecosystem services that wetlands provide.	Outline the services that wetlands can provide. As an extension, determine how we can test the health of the ecosystem. HW: My NASA data Hydrosphere and sea level maps and data	15

c. Content template:

<table>
<tr><td colspan="3">NGSS Standard:
HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-ESS3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity

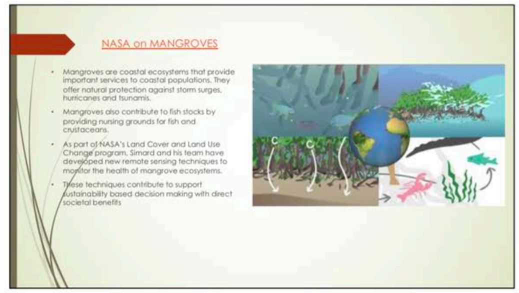
HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.</td><td colspan="1">Common Core Standard: RST.11.12; HSS.IC.A.2

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</td><td>NASA Science:
Earth Science</td></tr>
<tr><td>Content Area: Environmental Science
Grade Level:11 & 12 grade</td><td colspan="2">Name of Project-Based Activity or Theme: Understanding economic and ecosystem services of wetlands.</td><td>Estimated Time Frame to Complete(days/weeks): 2 days</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Overall Investigation Question(s): How can we investigate the importance of wetlands in their economic and ecosystem services?</td></tr>
<tr><td colspan="5">Overall Project Description/Activity: View NASA video clips on Saltmarshes and Mangroves. Students will understand the economic and ecosystem services that wetlands provide as well the biodiversity exhibited in these ecosystems</td></tr>
<tr><td></td><td>:</td><td></td><td></td><td></td></tr>
<tr><td>Materials Needed to Complete Project (put N/A as needed).</td><td>Stakeholders:</td><td>Hyperlinks Used:
NASA on Mangroves
https://www.youtube.com/watch?time_continue=24&v=RjSTKItUUX0
NASA on Saltmarshes
https://youtu.be/pLlu2WiU-z8</td><td>Multimedia/Technology:</td><td>Classroom Equipment:</td></tr>
<tr><td>Descriptions, illustrations of local saltmarsh flora & fauna, map to navigate through Alley Pond background research</td><td>Students, teacher, administrator</td><td></td><td>Smartboard, computer</td><td>smartboard</td></tr>
<tr><td>NASA System Engineering Behaviors
(2 behaviors per category)</td><td>Category (must have one Technical Acumen)</td><td>Activities
How will student model engineering behaviors when learning science content?</td><td>Student Outcomes
How will you assess learning for each behavior</td><td>Evaluation
Describe specific science content students understand as</td></tr>
</table>

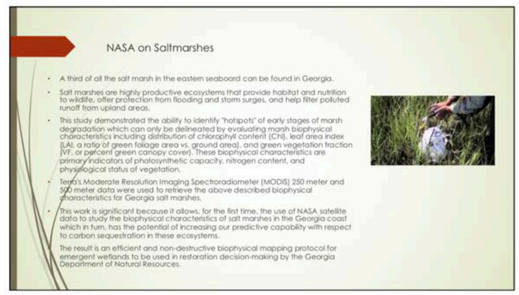
		Describe student activities here.		a result of engineering behavior.
Listens effectively and translates information	Communications	Students outline the ecosystem services that saltmarshes and mangroves provide, based on the video clips	Works cooperatively with team mates	Students are able to outline the ecosystem services that saltmarshes and mangroves provide, based on the video clips
Communicates effectively through personal interaction	Communications	Students work in groups to compare and contrast the various types of wetlands.	Works cooperatively with team mates	Students are able to work in groups to compare and contrast the various types of wetlands.
Builds Team Cohesion	Leadership	Students work in groups and exhibit shared responsibility	Works cooperatively with team mates	Students are able to work in groups to compare and contrast the various types of wetlands.
Appreciates/Recognizes Others	Leadership	Students work in groups and exhibit shared responsibility	Works cooperatively with team mates	Students are able to work in groups to adjust their answers and ask each other questions
Remain inquisitive and curious	Attitudes & Attributes	Students ask questions.	Student asks "why" questions	Students are able to develop a list of reason as to why characteristics of wetlands make them susceptible to exploitation
Seeks information and uses the art of questioning	Attitudes & Attributes	Students ask questions.	Utilizes the resources given and also uses internet searches to help each other	Students ask how humans can decrease their footprint on wetlands
Remains open minded and objective	Systems Thinking	Students brainstorm why characteristics of wetlands make the, susceptible to exploitation and harm.	Is willing to adjust answers and identifications as new information rises	Students can brainstorm ideas as to how we can minimize our impact
Keeps the focus on mission requirements	Systems Thinking	Students aim to complete the task on hand of listing characteristics of wetlands and comparing the different types of wetlands	Stays on task	Students ask how humans can decrease their footprint on wetlands
Learns from success and failures	Technical Acumen	Students are willing to revisit their answers to expand on them	Is willing to adjust answers	Students ask how humans can decrease their footprint on wetlands
List and attach all supportive documents for instructional activities	Attachments? (circle) Yes or No	List Attached Documents(if any):		
List and attach all rubrics for activity and assessment evaluation	Attachments? (circle) Yes or No	List Attached Rubrics (if any):		
Include comments or questions here:				

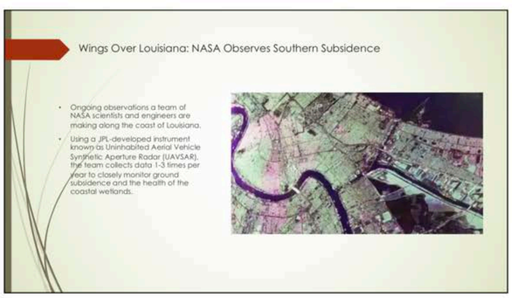
d. Supporting Documents:


Why are wetlands important?
Coastal wetlands, like salt marshes, mangroves, and tidal freshwater wetlands, have the capacity to be a major sink of greenhouse gasses since they store carbon in plant biomass, and can bury it long-term in salty oxygen-poor soils.
They can also emit greenhouse gasses. Because decay occurs in anoxic conditions, they can emit methane
If they erode and are lost to open water, carbon accumulated in the soil over centuries to millennia returns rapidly to the atmosphere.
Provide biodiversity
Coastal Wetlands (Florida)

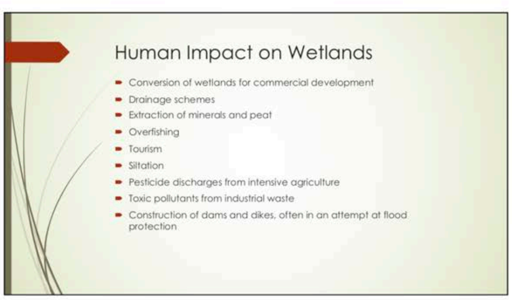

NASA on MANGROVES
Mangroves are coastal ecosystems that provide important services to coastal populations. They offer natural protection against storm surges, hurricanes and tsunamis.
Mangroves also contribute to fish stocks by providing nursing grounds for fish and crustaceans.
As part of NASA's Land Cover and Land Use Change program, Simard and his team have developed new remote sensing techniques to monitor the health of mangrove ecosystems.
These techniques contribute to support sustainability based decision making with direct societal benefits


Types of Wetlands
Saltmarshes
Salt marshes are coastal wetlands that are flooded and drained by salt water brought in by the tides
Mangroves
A mangrove is a woody tree or shrub that lives along sheltered coastlines within the tropic or subtropic latitudes.

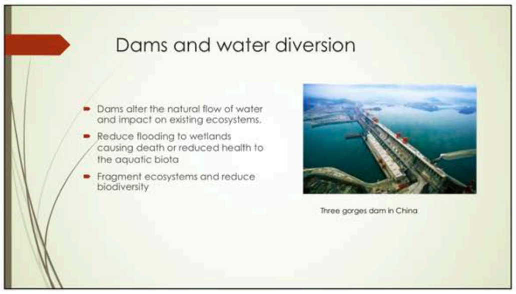

NASA on Saltmarshes
A third of all the salt marsh in the eastern seaboard can be found in Georgia.
Salt marshes are highly productive ecosystems that provide habitat and nutrition to wildlife, offer protection from flooding and storm surges, and help filter polluted runoff from upland areas.
This study demonstrated the ability to identify "hotspots" of early stages of marsh degradation which can only be delineated by evaluating marsh biophysical characteristics including distribution of chlorophyll content (Chl), leaf area index (LAI, a ratio of green foliage area vs. ground area), and green vegetation fraction (VF, or percent green canopy cover). These biophysical characteristics are primary indicators of photosynthetic capacity, nitrogen content, and physiological status of vegetation.
Terra's Moderate Resolution Imaging Spectroradiometer (MODIS) 250 meter and 500 meter data were used to retrieve the above described biophysical characteristics for Georgia salt marshes.
This work is significant because it allows, for the first time, the use of NASA satellite data to study the biophysical characteristics of salt marshes in the Georgia coast which in turn, has the potential of increasing our predictive capability with respect to carbon sequestration in these ecosystems.
The result is an efficient and non-destructive biophysical mapping protocol for emergent wetlands to be used in restoration decision-making by the Georgia Department of Natural Resources.

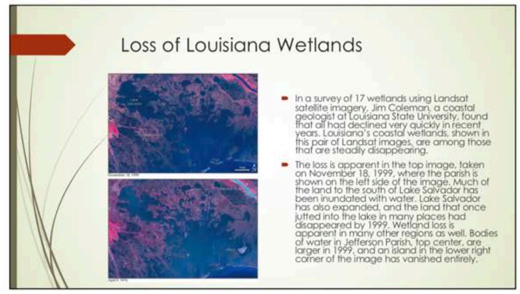

Wings Over Louisiana: NASA Observes Southern Subsidence
Ongoing observations a team of NASA scientists and engineers are making along the coast of Louisiana.
Using a JPL-developed instrument known as Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR), the team collects data 1-3 times per year to closely monitor ground subsidence and the health of the coastal wetlands.

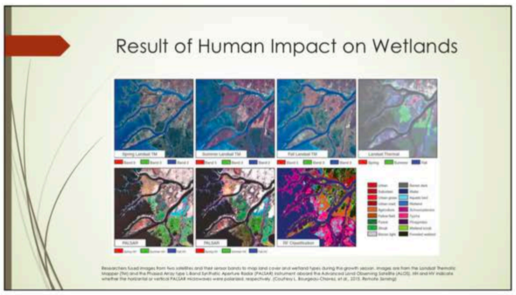

Industrial threats to wetlands
A major threat is the draining of wetlands for commercial development, including tourism facilities, or agricultural land.
Poor use of freshwater to feed these developments poses a further threat. The amount of water being taken from nature's underground aquifer is far outstripping its ability to replenish itself.
The result is that as the water level drops, millions of trees and plants are dying because they are deprived of their life-sustaining supplies.

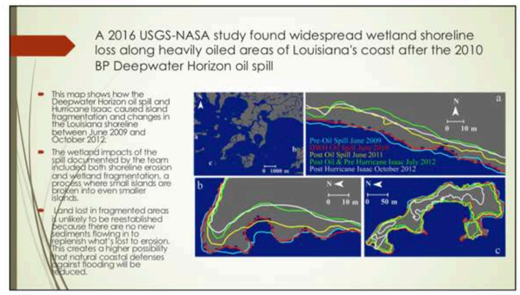

Human Impact on Wetlands
Conversion of wetlands for commercial development
Drainage schemes
Extraction of minerals and peat
Overfishing
Tourism
Siltation
Pesticide discharges from intensive agriculture
Toxic pollutants from industrial waste
Construction of dams and dikes, often in an attempt at flood protection


Agriculture as a threat to wetlands
Hundreds of thousands of hectares of wetlands have been drained for agriculture.
Globally, agriculture accounts for 65% of the total water withdrawal on Earth.
Agriculture and other industries such as paper making are often very wasteful and inefficient with water


Dams and water diversion
Dams alter the natural flow of water and impact on existing ecosystems.
Reduce flooding to wetlands causing death or reduced health to the aquatic biota
Fragment ecosystems and reduce biodiversity
Three gorges dam in China

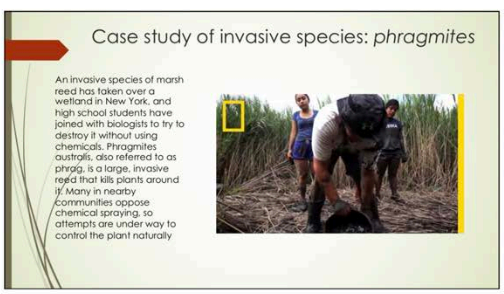

Loss of Louisiana Wetlands
In a survey of 17 wetlands using Landsat satellite imagery, Jim Coleman, a coastal geologist at Louisiana State University, found that all had declined very quickly in recent years. Louisiana's coastal wetlands, shown in this pair of Landsat images, are among those that are steadily disappearing.
The loss is apparent in the top image, taken on November 18, 1999, where the parish is shown on the left side of the image. Much of the land to the south of Lake Salvador has been inundated with water. Lake Salvador has also expanded, and the land that once jutted into the lake in many places had disappeared by 1999. Wetland loss is apparent in many other regions as well. Bodies of water in Jefferson Parish, top center, are larger in 1999, and an island in the lower right corner of the image has vanished entirely.

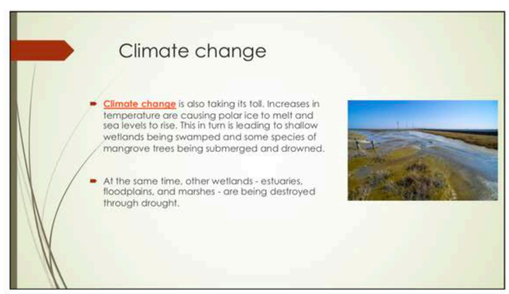

Result of Human Impact on Wetlands


A 2016 USGS-NASA study found widespread wetland shoreline loss along heavily oiled areas of Louisiana's coast after the 2010 BP Deepwater Horizon oil spill
This map shows how the Deepwater Horizon oil spill and Hurricane Isaac caused island fragmentation and changes in the Louisiana shoreline between June 2009 and October 2012.
The wetland impacts of the spill documented by the team included both shoreline erosion and wetland fragmentation, a process where small islands are broken into even smaller islands.
Land lost in fragmented areas is unlikely to be reestablished because there are no new sediments flowing in to replenish what's lost to erosion. This creates a higher possibility that natural coastal defenses against flooding will be reduced.
Pre-Oil Spill June 2009
Post Oil Spill June 2011
Post Oil & Pre Hurricane Isaac July 2012
Post Hurricane Isaac October 2012
0 1000 m
0 10 m
0 50 m


Invasive Species as a threat to wetlands
Alien invasive species have had severe impacts on local aquatic flora and fauna, and can upset the natural balance of an ecosytem.
For example, the introduction of phragmites at many wetland areas. Invasive species displace native species.


Pollution
Pollution in wetlands is a growing concern, affecting drinking water sources and biological diversity.
Drainage and run-off from fertilized crops and pesticides used in industry introduce nitrogen and phosphorous nutrients and other toxins like mercury to water sources.
These chemicals can affect the health and reproduction of species, posing a serious threat to biological diversity.


Case study of invasive species: phragmites
An invasive species of marsh reed has taken over a wetland in New York, and high school students have joined with biologists to try to destroy it without using chemicals. Phragmites australis, also referred to as phrag, is a large, invasive reed that kills plants around it. Many in nearby communities oppose chemical spraying, so attempts are under way to control the plant naturally


Climate change
Climate change is also taking its toll. Increases in temperature are causing polar ice to melt and sea levels to rise. This in turn is leading to shallow wetlands being swamped and some species of mangrove trees being submerged and drowned.
At the same time, other wetlands - estuaries, floodplains, and marshes - are being destroyed through drought.


Wings over Louisiana
The team collects data 1-3 times per year to closely monitor ground subsidence and the health of the coastal wetlands
NASA observes land subsidence

Why are wetlands essential in their ecosystem and economic service?

In groups of three, discuss the characteristics of wetland ecosystems and how wetlands are susceptible to human exploitation. Then jot down your answers below.

1. Types of wetlands (be specific and indicate characteristics that are specific to each type that make them unique)

____

____

2. General characteristics of wetlands (relative quantity of water, types of vegetation and animals, etc.)

____

____

3. Human impact & resulting consequence

____

____

____

____

____

Why are wetlands essential in their ecosystem and economic service?
EXIT SLIP

Briefly describe FOUR ecosystem and/or economic services that wetlands provide

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

Why are wetlands essential in their ecosystem and economic service? ANSWER KEY (POSSIBLE ANSWERS)

In groups of three, discuss the characteristics of wetland ecosystems and how wetlands are susceptible to human exploitation. Then jot down your answers below.

1. Types of wetlands (be specific and indicate characteristics that are specific to each type that make them unique)

Mangroves, freshwater marshes, saltwater marshes

2. General characteristics of wetlands (relative quantity of water, types of vegetation and animals, etc.)

A wetland is an area of land that is either covered with water or saturated with water for significant periods of time. Unique plants, called hydrophytes, define wetland ecosystems. Wetlands have a great deal of biodiversity. We can find turtles, frogs, and a variety of birds.

3. Human impact & resulting consequence

   a. Dams and diversion of waters results in sediment accumulation behind the dam
   b. Drainage and development results in destruction of habitats and reduction of biodiversity
   c. Agricultural run off results in increased nitrogen and dangerous algae blooms.
   d. Pesticide use, pollution results in habitat loss
   e. Clearing of wetlands results in flooding, decreased storm protection, release of stores carbon

Why are wetlands essential in their ecosystem and economic service?
EXIT SLIP
ANSWER KEY

Briefly describe FOUR ecosystem and/or economic services that wetlands provide

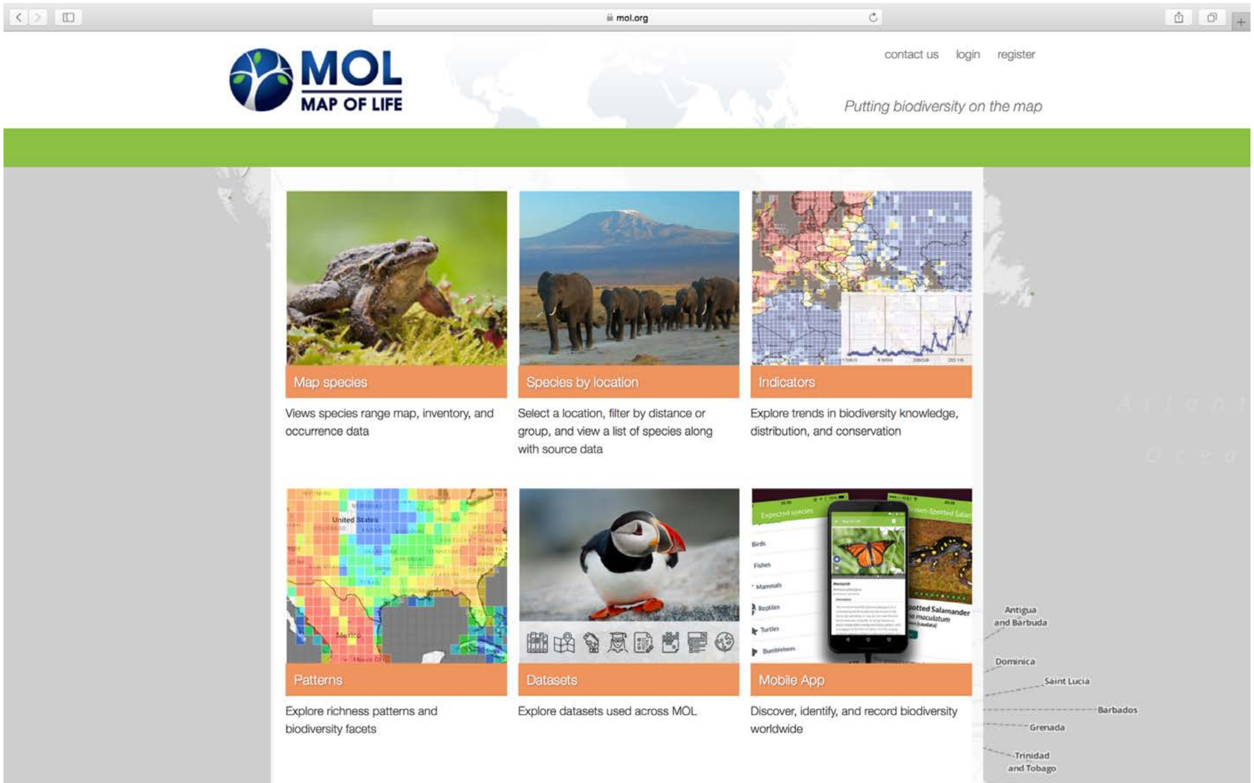
1. Provide coasts with storm protection
2. Provide habitats and promote biodiversity
3. Water filtration
4. Provide recreational space
5. Sequester/store carbon

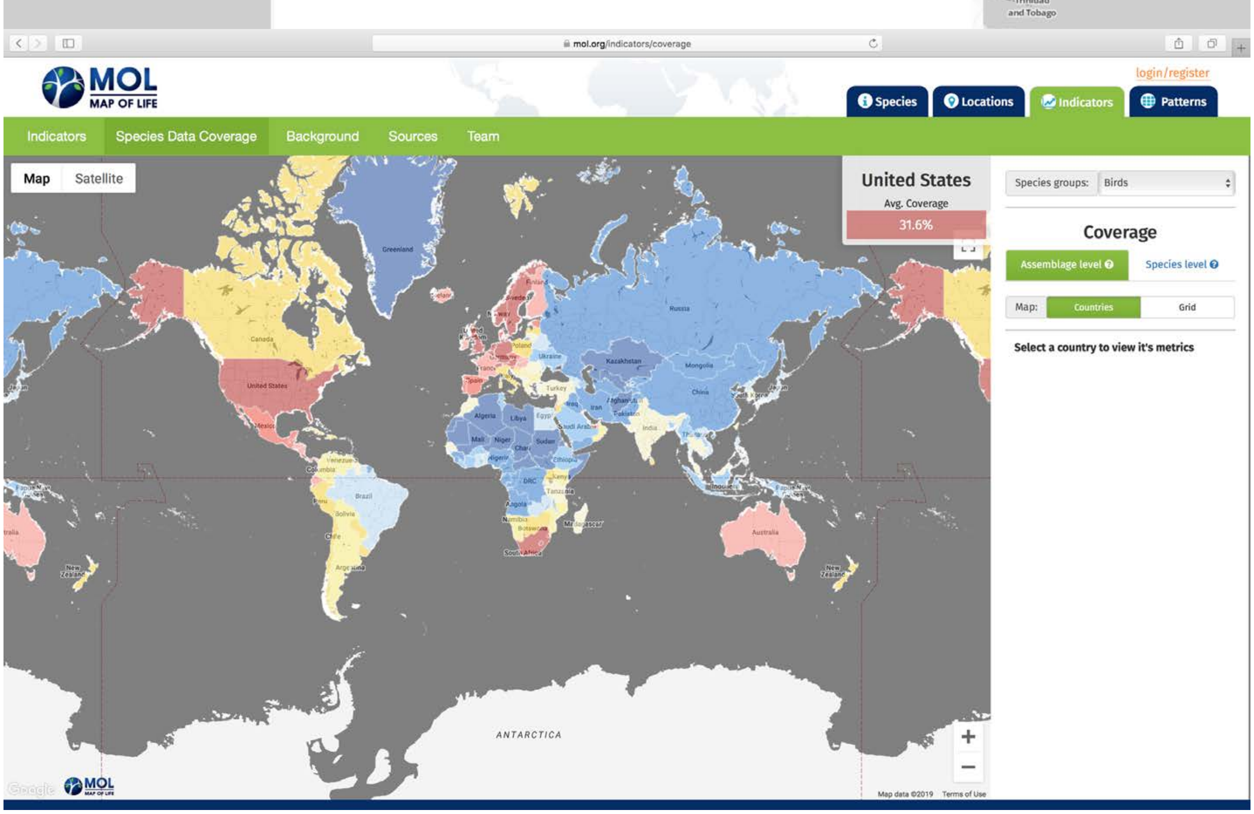
Differentiated instruction activities

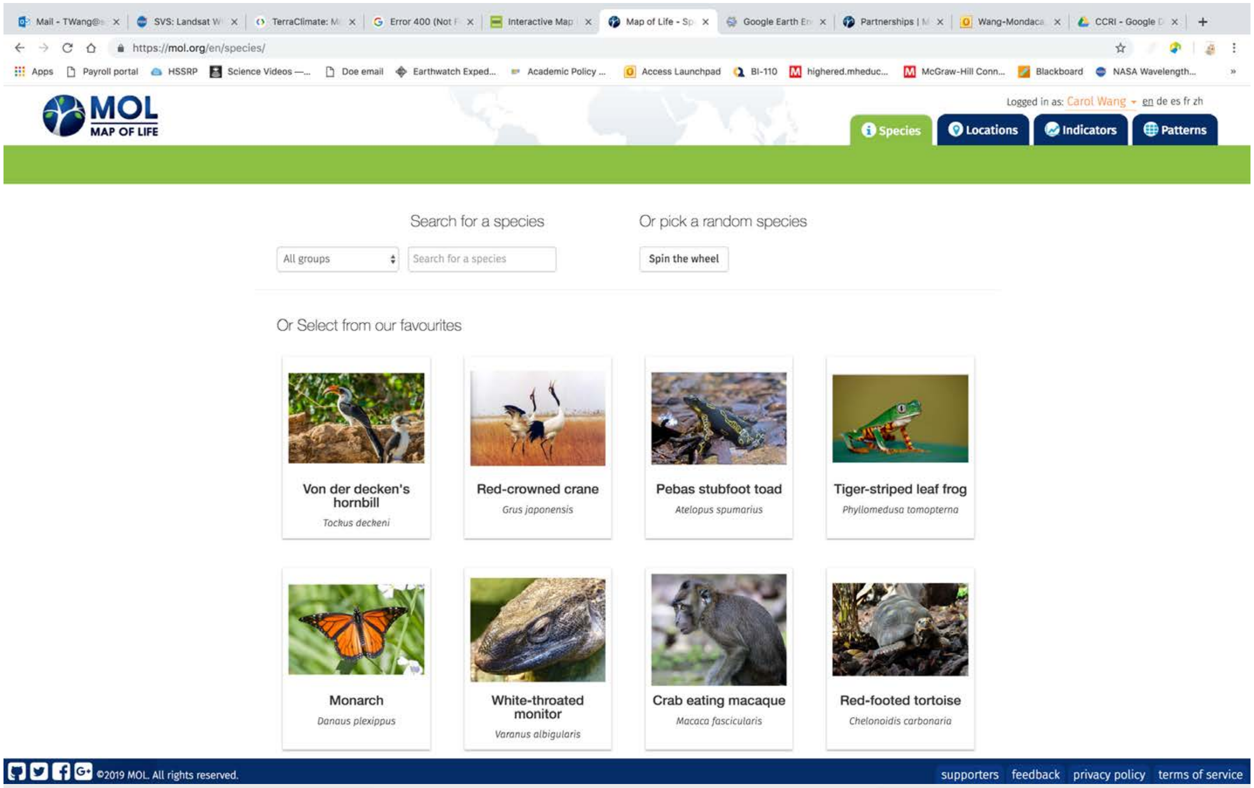
- Students work in heterogeneous groups and are grouped by reading and writing skill levels
- Presentation of information is multimodal and heavily supplemented with illustrations
- Students are asked a range of questions, representing lower and higher level questions (What, why, how?)
- Students will use technology/websites in a highly interactive activity to determine species richness

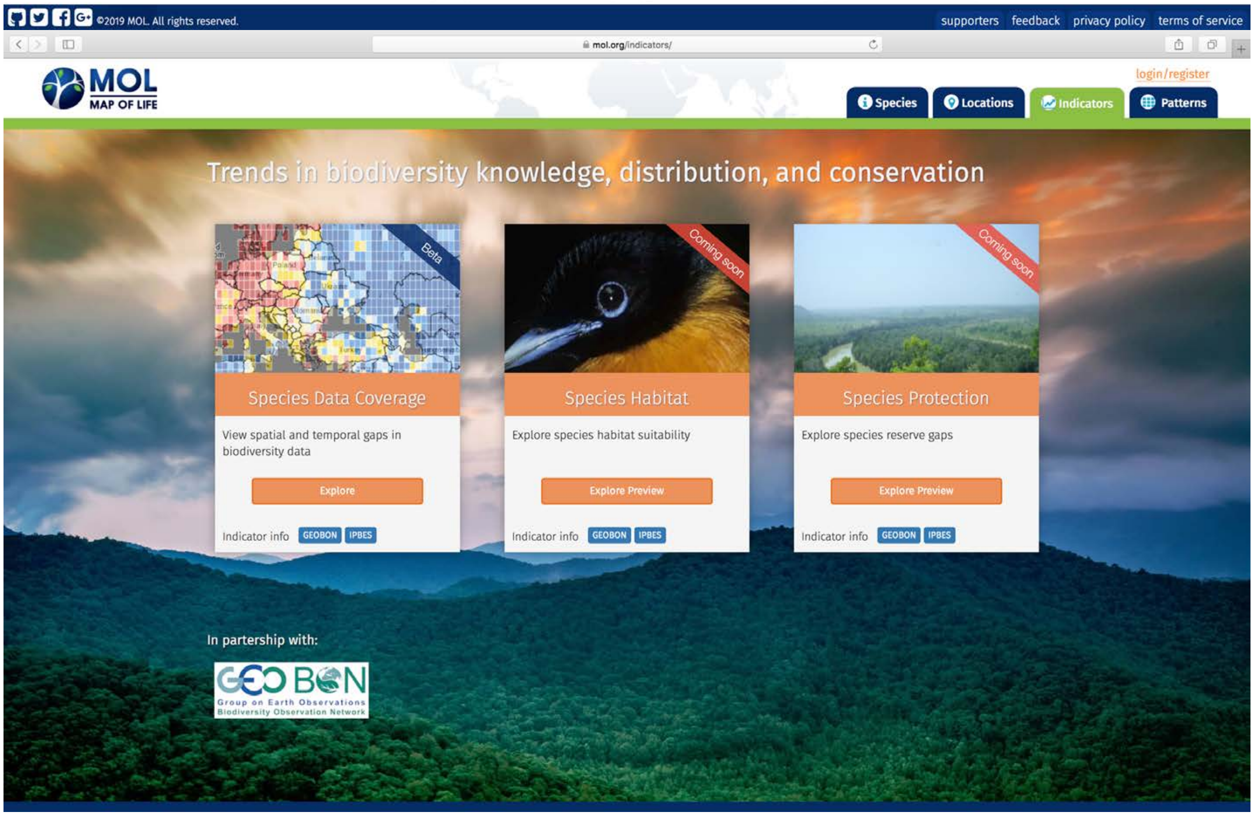
Discussion prompts:

- Students view images of wetlands and discuss what they all have in common to come to a consensus to define/describe exactly what a wetland is
- Students are asked to hypothesize what threats might exist to wetlands.
- Students discuss what can be done to decrease human impact.
- How do we define species richness? What does the Map of Life website tell us?


mol.org
contact us
login
register
MOL
MAP OF LIFE
Putting biodiversity on the map
Map species
Views species range map, inventory, and occurrence data
Species by location
Select a location, filter by distance or group, and view a list of species along with source data
Indicators
Explore trends in biodiversity knowledge, distribution, and conservation
Patterns
Explore richness patterns and biodiversity facets
Datasets
Explore datasets used across MOL
Mobile App
Discover, identify, and record biodiversity worldwide


mol.org/indicators/coverage
MOL
MAP OF LIFE
login/register
Species
Locations
Indicators
Patterns
Indicators
Species Data Coverage
Background
Sources
Team
Map
Satellite
United States
Avg. Coverage
31.6%
Species groups:
Birds
Coverage
Assemblage level
Species level
Map:
Countries
Grid
Select a country to view it's metrics
ANTARCTICA


MOL
MAP OF LIFE
Species
Locations
Indicators
Patterns
Search for a species
Or pick a random species
All groups
Search for a species
Spin the wheel
Or Select from our favourites
Von der decken's hornbill
Tockus deckeni
Red-crowned crane
Grus japonensis
Pebas stubfoot toad
Atelopus spumarius
Tiger-striped leaf frog
Phyllomedusa tomopterna
Monarch
Danaus plexippus
White-throated monitor
Varanus albigularis
Crab eating macaque
Macaca fascicularis
Red-footed tortoise
Chelonoidis carbonaria
©2019 MOL. All rights reserved.
supporters
feedback
privacy policy
terms of service


mol.org/indicators/
MOL
MAP OF LIFE
login/register
Species
Locations
Indicators
Patterns
Trends in biodiversity knowledge, distribution, and conservation
Beta
Species Data Coverage
View spatial and temporal gaps in biodiversity data
Explore
Indicator info
GEOBON
IPBES
Coming soon
Species Habitat
Explore species habitat suitability
Explore Preview
Indicator info
GEOBON
IPBES
Coming soon
Species Protection
Explore species reserve gaps
Explore Preview
Indicator info
GEOBON
IPBES
In partnership with:
GEO BON
Group on Earth Observations Biodiversity Observation Network

Conclusion and overview of linkages to next lesson and unit goals.

This introductory lesson presents the importance of marshlands and leads into the next lesson where students visit an actual saltmarsh. They will be able to observe firsthand the biodiversity and ecosystem services that the marsh provides.

MOL
MAP OF LIFE

What is Map of Life?

Geographic information about biodiversity is vital for understanding the many services nature provides and their potential changes, yet remains unreliable and often insufficient. Built on a scalable web platform geared for large biodiversity and environmental data, **Map of Life** endeavors to provide 'best-possible' species range information and species lists for any geographic area.

1) Go to https://mol.org/
2) Click on the species tab
3) Select a species, either using the "spin the wheel" button, select from "Our favorites" or input a species you want to know more about
4) Note the status of the species (endangered, etc). What information does the detailed map give you? The projection?
5) Click on patterns
6) Click on species richness
    a. What is species richness?
    b. What is species rarity?
7) Click on indicators.
    a. What is an indicator species? Why are birds considered indicator species?
8) Provide a summary and background information of at least **3** species using the **Map of Life.**

Powered by

Google Earth Engine

Supported by

NASA NSF MacArthur Foundation

Jetz, W., McPherson, J. M., and Guralnick, R. P. (2012). Integrating biodiversity distribution knowledge: toward a global map of life. Trends in Ecology and Evolution 27:151-159. DOI:10.1016/j.tree.2011.09.007

MOL MAP OF LIFE

What is Map of Life? ANSWER KEY

Geographic information about biodiversity is vital for understanding the many services nature provides and their potential changes, yet remains unreliable and often insufficient. Built on a scalable web platform geared for large biodiversity and environmental data, **Map of Life** endeavors to provide 'best-possible' species range information and species lists for any geographic area.

1) Go to https://mol.org/
2) Click on the map species tab
3) Select a species, either using the "spin the wheel" button, select from "Our favorites" or input a species you want to know more about
4) Note the status of the species (endangered, etc). What information does the detailed map give you? The projection?
   The detailed map provides information on local inventories, point observations, gridded surveys, regional checklists. The projection indicates the population projection of the species—whether or not there will be a decline in population.
5) Click on patterns
6) Click on species richness
   a. What is species richness? Species richness is the number of different species represented in an ecological community, landscape or region. It does not take into account the relative abundance of the species.
   b. What is species rarity?Most species are represented by a few individuals. Species rarity is a measure of how rare a species is.
7) Click on indicators.
   a. What is an indicator species? Why are birds considered indicator species?

   An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the condition of a particular ecosystem. It can therefore be used to diagnose the health of an ecosystem. Birds are intimately linked to their ecosystem. Their presence or absence are good indicators of the health of their ecosystem.

8) Provide a summary and background information of at least **3** species using the **Map of Life. Answers will vary.**

Powered by

Google Earth Engine

Supported by

MacArthur Foundation

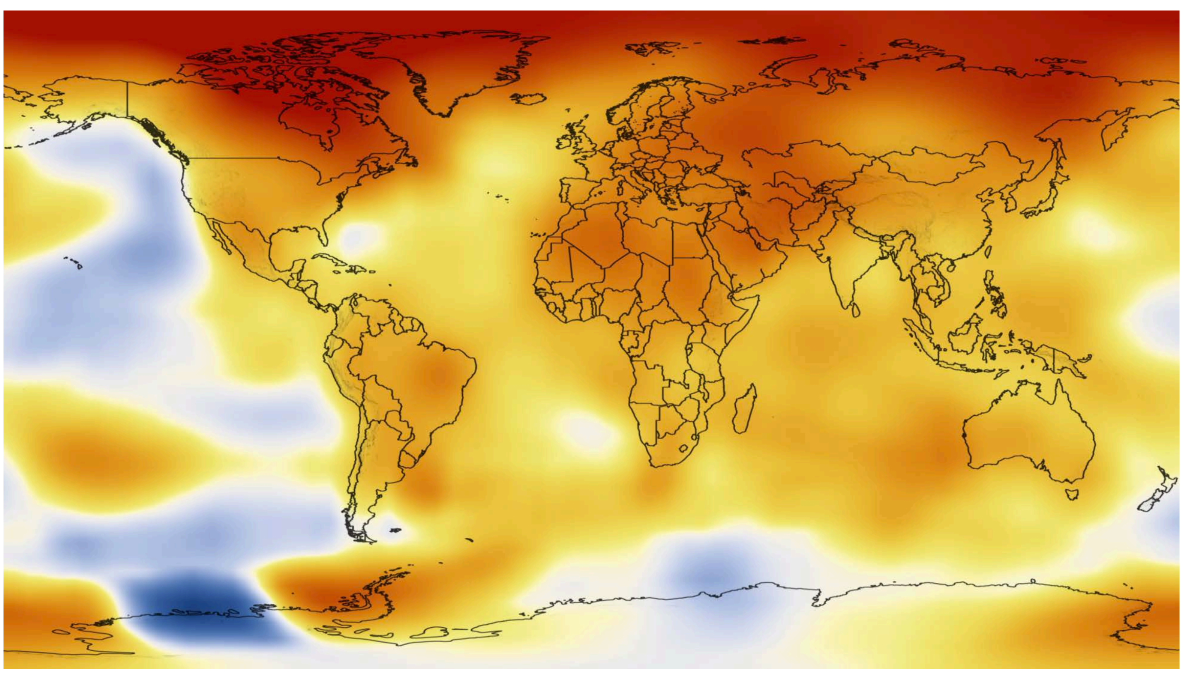
Jetz, W., McPherson, J. M., and Guralnick, R. P. (2012). Integrating biodiversity distribution knowledge: toward a global map of life. Trends in Ecology and Evolution 27:151-159. DOI:10.1016/j.tree.2011.09.007

National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Goddard Institute for Space Studies (GISS)
Climate Change Research Initiative (CCRI)
Applied Research STEM Curriculum Portfolio

Unit Title: Wetlands

Lesson Title: Observing the saltmarsh at Alley Pond Park
NASA STEM Educator / Associate Researcher: Carol Wang-Mondaca
NASA PI / Mentor: Dr. Dorothy Peteet
NASA GSFC Office of STEM Engagement –160



IX. Lesson 2: Observing the Saltmarsh at Alley Pond Park

a. Summary and Goals of Lesson

Students will take a field trip to Alley Pond Park to observe the flora and fauna at the local saltmarsh ecosystem. In addition to exploring the biodiversity of wetlands, they will be able to see why they are so aptly named. The students will also be able to perform water quality testing, solid testing, and have some hands-on experience with native small animals, such as turtles and snakes, and learn about their roles in the ecosystem. Finally students will understand the role of humans in their impact on the saltmarsh. The nearby sewage overflow into the saltmarsh should demonstrate clear differences in the water and soil quality testing. The teacher needs to get trained in globe.gov so that students can upload data. GLOBE Training should be done as far in advance as possible via Globe website. GLOBE toolkit link located here so that the teacher can obtain required materials

b. Table of Contents for lesson

Lesson Title: Observing the saltmarsh at Alley Pond Park
Grade Level: 11th and 12th grades
Duration: One day field trip, with one day follow up
Teacher pre-requisite training: GLOBE protocol training and GLOBE toolkits.
GLOBE Training (https://www.globe.gov/get-trained/protocol-etraining) should be done as far in advance as possible via Globe website.
GLOBE toolkit link (https://www.globe.gov/documents/10157/380993/Tool+Kit) so that the teacher can obtain required materials

*** This lesson can apply to any wetland in the United States. To modify this lesson for any wetland in any area, teachers can go to the Wetlands Mapper, https://www.fws.gov/wetlands/data/Mapper.html, which is a part of the National Wetlands Inventory provided by the US Fish and Wildlife Service. Teachers can find local wetlands nearby their school for a daytrip. Additionally, the National Environmental Education Foundation lists United Wetlands by state (https://www.neefusa.org/nature/land/wetlands-united-states, which links back to the US Fish and Wildlife Service with specific wetlands in that state. The site provides highlights of what fauna and flora are found in each of the wetlands.

The scavenger hunt can be done with local flora and fauna and the images in the handout replaced with local organisms.

	What the Teacher Does	**What the Students Do**	**Duration**
Engage: **Pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.**	The teacher sends the students, in groups, on a scavenger hunt, looking for saltmarsh flora and fauna typical of that area. The teacher provides the students with some pictures and keys as well as a map of Alley Pond Park. HANDOUT: WETLANDS IN OUR BACKYARD	Designate the roles within their group—team leader, navigator sketch artist, note taker.	20 minutes
Explore: **The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.**	The teacher sets the students to explore the marsh.	Students will, within their group, locate, identify, sketch and write a brief description of flora and fauna that they find. Students will use their cell phones as a resource as well as the keys provided by the teacher	1.5 hours

Explain: Provide students with an opportunity to communicate what they have learned so far and figure out what it means. EXPLAIN	Teacher asks students to collaborate with each other and sketch out a food web of the organisms that they find.	Students need to then research the background of the species that they find as well as their role/niche in the ecosystem.	2 hours
Elaborate / Extend: allow students to use their new knowledge and continue to explore its implications.	Teacher explains what an invasive species is and helps to identify one. Teacher elicits that invasive species are usually brought in unintentionally and that they thrive because they lack natural predators and outcompete for resources. Teacher provides LaMotte water testing kits to students. Encourages students to test near the sewage overflow area, by the highway, as well as further into the park and presumably further away from human impact. ** Teacher gets trained in globe.gov so that students can upload data. GLOBE Training (https://www.globe.gov/get-trained/protocol-etraining) should be done as far in advance as possible via Globe website. *** GLOBE toolkit link located here (https://www.globe.gov/documents/10157/380993/Tool+Kit)	Students will identify invasive species and explain their role in the ecosystem, as well as discuss why invasive species should or should not be controlled/removed. Students map out where they want to collect water samples. Students practice safe and sterile lab techniques to collect vials of water. Students will perform water quality tests once they	2 hours

		return to the lab. Students will compare and contrast their data with the other groups and, based on the data, draw some conclusions to explain their data and any similarities/differences with other groups.	
Evaluate: **Both students and teachers to determine how much learning and understanding has taken place.**	Teacher will evaluate the students' food webs, their sketches and identifications as well as their stand and support for or against the removal of invasive species Teacher will evaluate students lab protocols and their analysis and explanation of data, going group by group	Students will share each other's webs and sketches and see if the other groups can identify the species they found and if they found ones in common. Students will ask each other about the organisms' niches. Students must be able to explain their data and present it to the rest of the class.	30 minutes 45 minutes

c. Content template:

NGSS Standards and NYS Science Standards HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. HS-ESS3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on		Common Core Standard: RST.11.12; HSS.IC.A.2 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.		NASA Science: Earth Science
Content Area: Environmental Science Grade Level:11 & 12 grade	Name of Project-Based Activity or Theme: Understanding economic and ecosystem services of wetlands at Alley Pond Park		Estimated Time Frame to Complete(days/weeks): 3 days	
Overall Investigation Question(s): How can we investigate the importance of wetlands in their economic and ecosystem services: case study at Alley Pond Park?				
Overall Project Description/Activity: Visit Alley Pond Park, a saltmarsh and survey flora and fauna that are native to the saltmarsh.				
	:			
Materials Needed to Complete Project (put N/A as needed).	Stakeholders:	Hyperlinks Used: https://www.giss.nasa.gov/research/briefs/hartig_01/ https://climate.nasa.gov/news/1045/an-ecosystem-feels-the-human-touch/ https://earthobservatory.nasa.gov/images/52125/sediment-plumes-in-the-hudson-river	Multimedia/Technology Smartboard, computer:	Classroom Equipment: smartboard
Descriptions, illustrations of local saltmarsh flora & fauna, map to navigate through Alley Pond background research	Students, teacher, administrator, Alley Pond personnel			
NASA System Engineering Behaviors (2 behaviors per category)	Category (must have one Technical Acumen)	Activities How will student model engineering behaviors when learning science content? Describe student activities here.	Student Outcomes How will you assess learning for each behavior	Evaluation Describe specific science content students understand as a result of engineering behavior.
Listens effectively and translates information	Communications	Students will break up in to teams to identify various flora and fauna in the saltmarsh and attempt to make interspecies connections	Works cooperatively with team mates	
Communicates effectively	Communications	Each student will be assigned a role in the team with their	Completes the scavenger hunt assignment	

through personal interaction		own responsibilities (recorder, note taker, sketch artist, guide to navigate through the area, etc.)	successfully with group members	
Builds Team Cohesion	Leadership	Scavenger hunt type of activity will motivate students to search for different species of organisms, and if accompanied by descriptions will provide clues		
Appreciates/Recognizes Others	Leadership	The team aspect of the activity helps students recognize others and the information they offer		
Remain inquisitive and curious	Attitudes & Attributes	The desire to complete the activity and complete the scavenger hunt should lend itself to keeping the students curious.		
Seeks information and uses the art of questioning	Attitudes & Attributes	The students should be utilizing their phones, handouts and each other as information sources	Utilizes the resources given and also uses internet searches to help each other	
Remains open minded and objective	Systems Thinking		Is willing to adjust answers and identifications as new information rises	
Keeps the focus on mission requirements	Systems Thinking		Stays on task	
Learns from success and failures	Technical Acumen		Is willing to adjust answers	
List and attach all supportive documents for instructional activities	Attachments? (circle) Yes or No	List Attached Documents(if any):		
List and attach all rubrics for activity and assessment evaluation	Attachments? (circle) Yes or No	List Attached Rubrics (if any):		
Include comments or questions here:				

Water quality testing

1) Before you begin, make sure you sketch your location. Take particular note of your surroundings as they may affect your water quality tests (highway location, sewer, houses, APEC location, etc.)

2) You will collect water samples into the glass test tubes with the twist on caps. You must label each tube with your group number and location.

3) You will be using the LaMotte water quality testing kits to determine the values below once we return to the lab.

4) You must follow instructions as some of the tests require the dissolving of a pellet in the water and matching it to a given color wheel.

Avoid contamination and clearly label your samples. We will be following the GLOBE protocols. You must adhere to these protocols in order to be able to upload them to the GLOBE database.

Factor	Normal Range:	Your reading:	What does this mean? (rationale behind the test and what your results mean)
Temperature			
pH			
Dissolved Oxygen			
Nitrates			
Phosphates			
Total Coliform Bacteria			
Turbidity			
Total Dissolved solids and salinity			

Conclusions and Analysis:

Explain the significance of each test and what your results mean. What conclusions can you draw? What further tests might you do? What environmental factors or testing factors may have affected your results?

Data upload:

Your data will be uploaded into the GLOBE, Global Learning and Observations to Benefit the Environment, database, www.globe.gov

Rubric

Measurements (part 1- 72 points)

2 – measurement taken 1—measurement taken, no units 0- no measurements taken	Normal Range (3 points each)	Your Reading (3 points each)	Rationale (3 points each)
1.Temperature			
2. pH			
3. Dissolved Oxygen			
4. Nitrates			
5. Phosphates			
6. Total Coliform Bacteria			
7. Turbidity			
8. Total Dissolved solids and salinity			
TOTAL POINTS	24	24	24

Total points Part 1_________

Questions (part 2- 28 points)

Conclusions & Analysis	Allotted points	Points Received
1.Significance of each test and what the results mean (2 pts each)	16	
2. Conclusions	6	
3. Environmental factors or testing factors that may have affected results.	6	

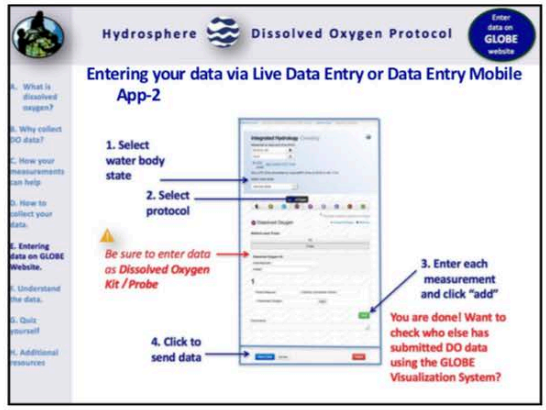
Total points Part 2________

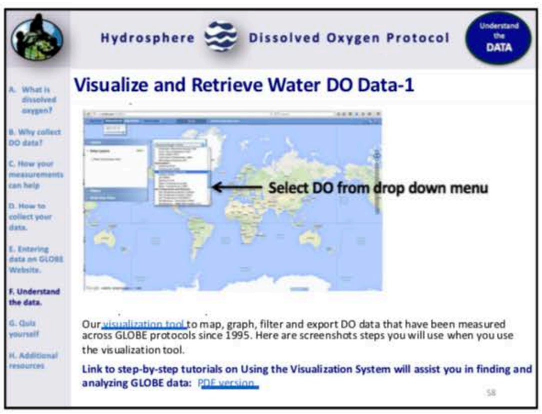
Total Points (part 1 + part 2)___________

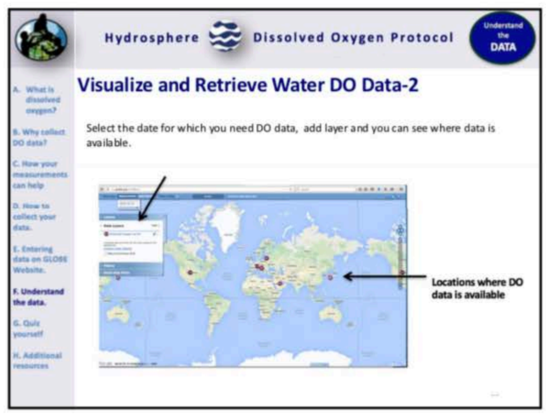
The GLOBE Program: Global Learning and Observations to Benefit the Environment

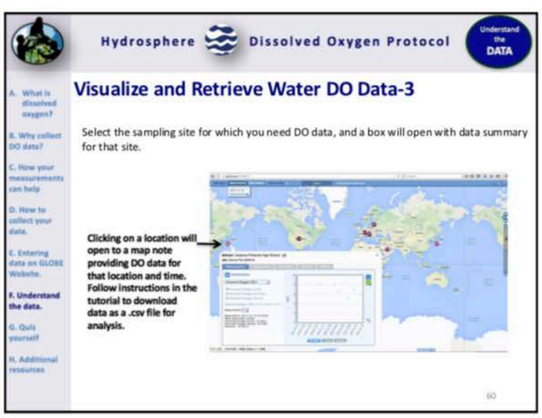
Sponsored by: Supported by:

GLOBE DATA UPLOAD INSTRUCTIONS:









Alley Pond Park—wetlands in our backyard.

Salt marshes play a critical role in the support of human life, acting as natural filtration systems by trapping pollutants that would otherwise contaminate our bays and oceans. Salt marshes have the ability to absorb fertilizers, improve water quality, and reduce erosion. They are also among the richest wildlife habitats.

Alley Pond Park, the second-largest park in Queens, lies on a glacier-formed moraine – a ridge of sand and rock that formed 15,000 years ago. The glacier, which dropped the boulders that sit on the hillsides of the park's southern end, also left buried chunks of ice that melted and formed the ponds dispersed throughout the Alley, the 150-acre strip of wetlands in the north end of the park. Freshwater drains into the Alley from the hills and bubbles up from natural springs, mixing with the salt water from Little Neck Bay. As a result, the park is host to freshwater and saltwater wetlands, tidal flats, meadows, and forests, making for a diverse ecosystem and supporting abundant bird life

When the last of the glaciers melted 7,000 years ago, the oceans rose to their present levels. Sediments washed from the land were deposited offshore in narrow sandy strips, forming long islands parallel to the shoreline. These barrier beaches received the pounding surf on their ocean side, but had calm, protected bays behind their landward shores. While the waters were calm enough for vegetation to take root, the presence of saltwater made survival difficult. One species, however, saltmarsh cordgrass (*Spartina alterniflora*), was able to colonize the flat expanses of sand and silt, which were covered twice a day by the ocean's tides. Today, the grass is still found along the Atlantic coast.

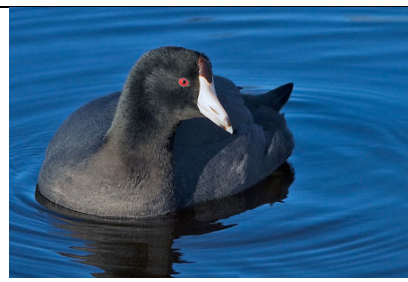
As this specialized grass spreads, its stems trap floating debris. Sediments and particles of decaying matter slowly build up, forming nutrient-rich mud. This mud, called detritus, supports life on the marsh. It is the basis of a complex food web in which energy is passed from one organism to another. The fiddler crab (*Uca*) and ribbed mussel (*Geukensia demissa*) have developed a mutually beneficial relationship with the saltmarsh cordgrass. While the crabs and mussels benefit from feeding on decaying matter trapped within cordgrass roots, cordgrass gains from the fiddler's burrowing, which aerates the soil, and the mussel's excretion, which provides necessary nitrogen.

At the end of each season, the cordgrass dies, creating a spongy peat. Each year's peat layer raises the surface of the marsh, enabling it to colonize new territory. A variety of plants with less salt tolerance can colonize the peat, as it is out of the range of most of the high tides. This causes the formation of two separate plant communities, the intertidal marsh and the salt meadow. A third type of salt marsh community is the mudflat. Each of these communities has its own distinctive vegetation, insects, fish, birds, and mammals that have adapted to survive in a saltwater environment. The creek at the center of the Alley is lined by common reed (*Phragmites australis*) and further north by fertile salt marsh. Visitors to the marshes of Alley Pond Park can often see herons and egrets. Occasionally, a muskrat (*Ondatra zibethica*) can be spotted on the way to its secluded lodge among the reeds. While salt marshes do not have a very wide variety of species, the volume of life present is remarkable.

Since industrialization, human activity has destroyed many marshes. Where marshes are disturbed, reeds often grow in place of cordgrass. Since reeds do not decompose into as nutritious a substance as cordgrass, a reed marsh does not contribute as much to coastal ecosystems as a cordgrass marsh. In the last 200 years, humans have also filled over 80 percent of the city's original salt marshes for construction. While recent conservation efforts have improved the condition of marshes, this valuable ecosystem continues to disappear from the City at an alarming rate.

Alley Pond Scavenger hunt

Try and find as many of the organisms as you can below. Be careful where you go and avoid any unsafe areas—be aware of your surroundings. If you find something not listed here, sketch your organism and use your cell phone as a resource (or the ALLey Pond guide).

 osprey	 red-tailed hawk	 broad-winged hawk
 Wood ducks	 American coot	 Mallards
 Great horned own	 Yellow warblers	 Pine warblers
 Cardinals	 Rusty blackbirds	 Dark-eyed juncos

 Muskrat	 Red fox	 Snapping turtles
 Spotted Salamander	 Bullfrogs	 Lesser scaup
 Bobwhite quail	 Ring-necked pheasant	 Cooper's hawks
 Jewelweed	 Thistles	 Queens Anne's Lace

 Butterfly weed	 Tulip tree	 Inkberry, pokeberry or poke salad
 Burdock (inspired the invention of Velcro)	 Phragmites* (an invasive species)	 Cattails
 Northern saw-whet owl	 Northern shoveler	 White tailed deer
 Fowler's toads	 Spring peepers	 Salamander

  Red maple	  Red Oak	  White oak trees
  Sweet gum tree	  Sugar maple	  American beech

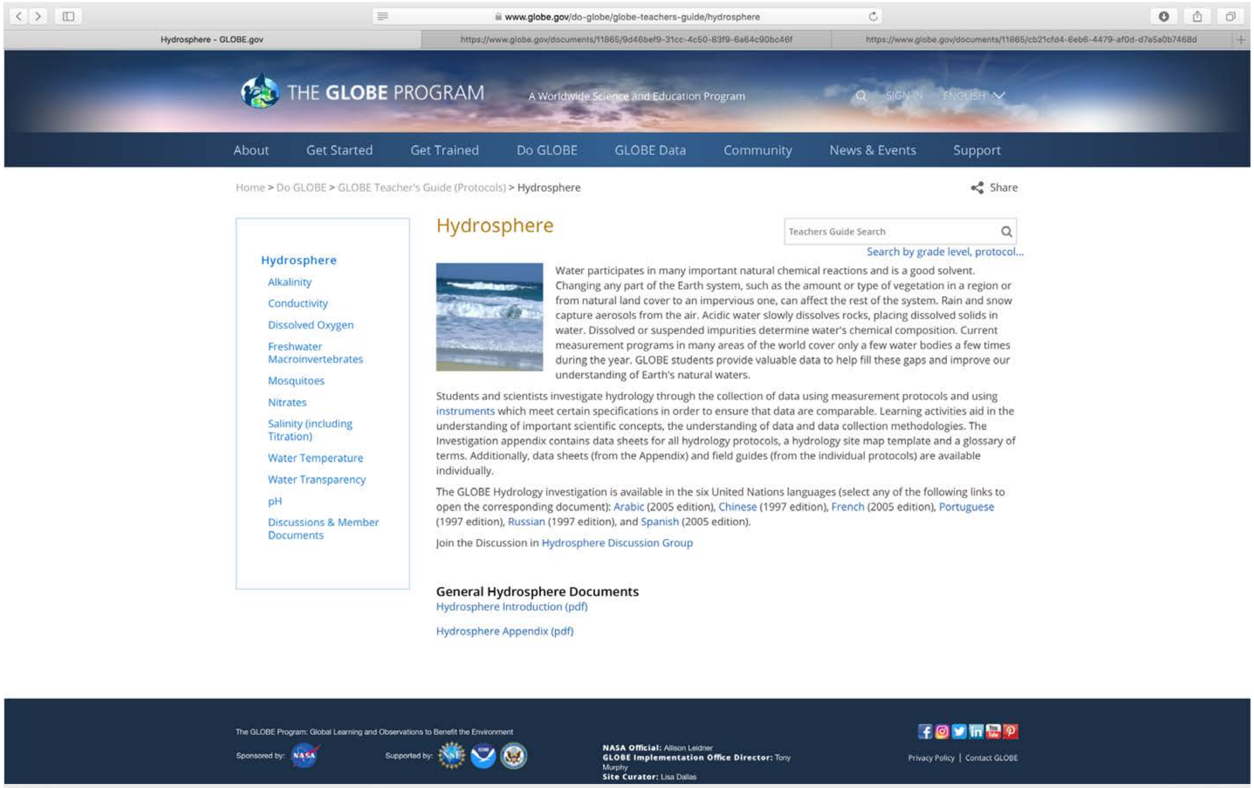
<u>Some Fish You May Find</u>
Bass
Blue gill
Perch
Carp

Differentiated instruction activities

- Students work in groups for this highly interactive activity
- Presentation of information is multimodal and heavily supplemented with illustrations
- Students are asked a range of questions, representing lower and higher level questions (What, why, how?)
- Students are working at different speeds and at different levels on what they can identify
- Students will be able to take on different roles in the lab when collecting and entering data

Discussion prompts

- Why do we find more plants than animals?
- Why is biodiversity essential for the health of an ecosystem?
- What does water testing tell us about the health of the wetlands?



Home > Do GLOBE > GLOBE Teacher's Guide (Protocols) > Hydrosphere

Hydrosphere

Hydrosphere
- Alkalinity
- Conductivity
- Dissolved Oxygen
- Freshwater Macroinvertebrates
- Mosquitoes
- Nitrates
- Salinity (including Titration)
- Water Temperature
- Water Transparency
- pH
- Discussions & Member Documents

Water participates in many important natural chemical reactions and is a good solvent. Changing any part of the Earth system, such as the amount or type of vegetation in a region or from natural land cover to an impervious one, can affect the rest of the system. Rain and snow capture aerosols from the air. Acidic water slowly dissolves rocks, placing dissolved solids in water. Dissolved or suspended impurities determine water's chemical composition. Current measurement programs in many areas of the world cover only a few water bodies a few times during the year. GLOBE students provide valuable data to help fill these gaps and improve our understanding of Earth's natural waters.

Students and scientists investigate hydrology through the collection of data using measurement protocols and using instruments which meet certain specifications in order to ensure that data are comparable. Learning activities aid in the understanding of important scientific concepts, the understanding of data and data collection methodologies. The Investigation appendix contains data sheets for all hydrology protocols, a hydrology site map template and a glossary of terms. Additionally, data sheets (from the Appendix) and field guides (from the individual protocols) are available individually.

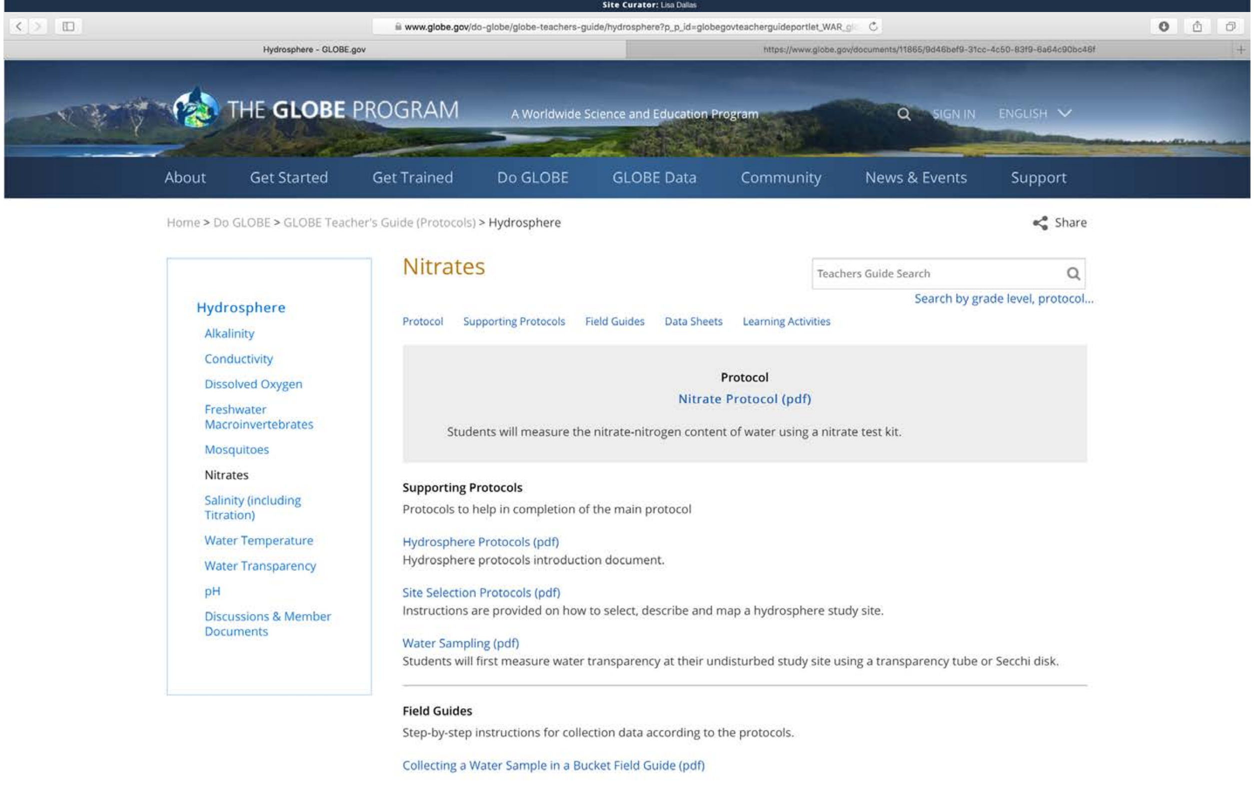
The GLOBE Hydrology investigation is available in the six United Nations languages (select any of the following links to open the corresponding document): Arabic (2005 edition), Chinese (1997 edition), French (2005 edition), Portuguese (1997 edition), Russian (1997 edition), and Spanish (2005 edition).

Join the Discussion in Hydrosphere Discussion Group

General Hydrosphere Documents

Hydrosphere Introduction (pdf)

Hydrosphere Appendix (pdf)



Home > Do GLOBE > GLOBE Teacher's Guide (Protocols) > Hydrosphere

Nitrates

Protocol | Supporting Protocols | Field Guides | Data Sheets | Learning Activities

Protocol

Nitrate Protocol (pdf)

Students will measure the nitrate-nitrogen content of water using a nitrate test kit.

Supporting Protocols

Protocols to help in completion of the main protocol

Hydrosphere Protocols (pdf)
Hydrosphere protocols introduction document.

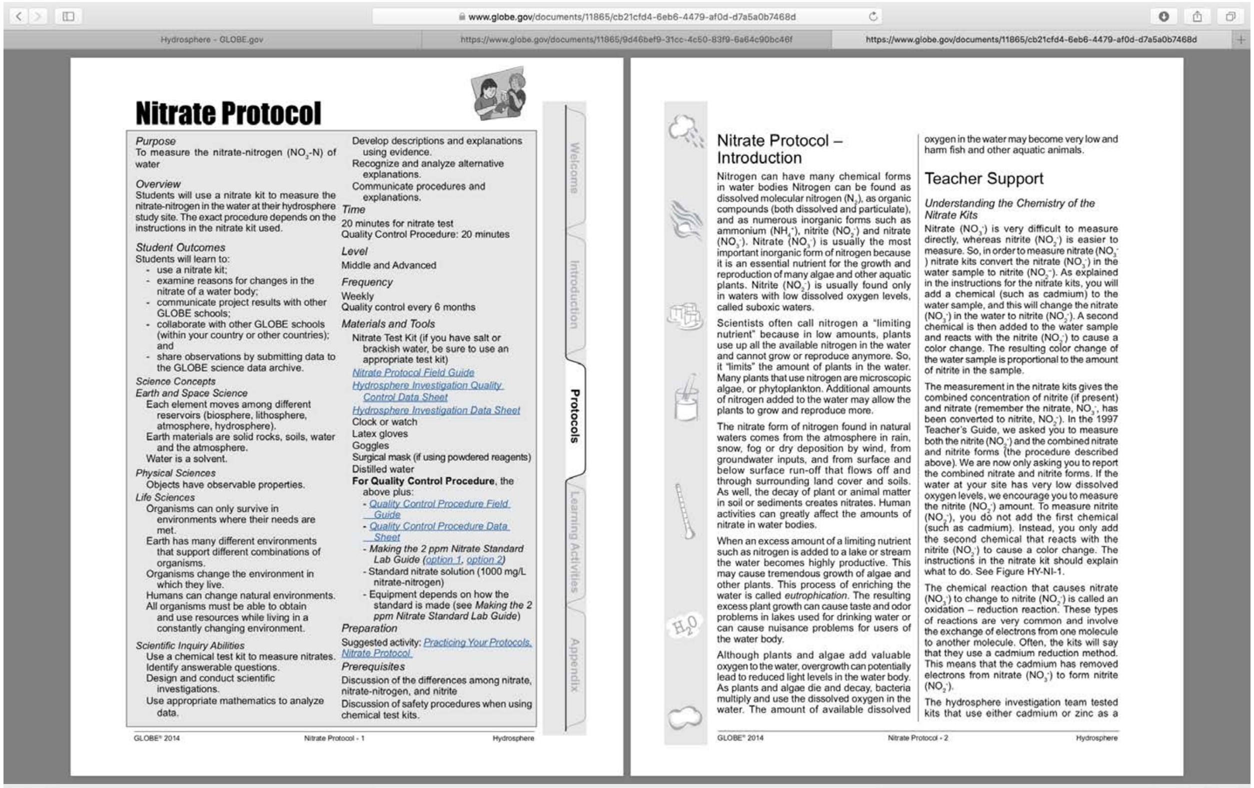
Site Selection Protocols (pdf)
Instructions are provided on how to select, describe and map a hydrosphere study site.

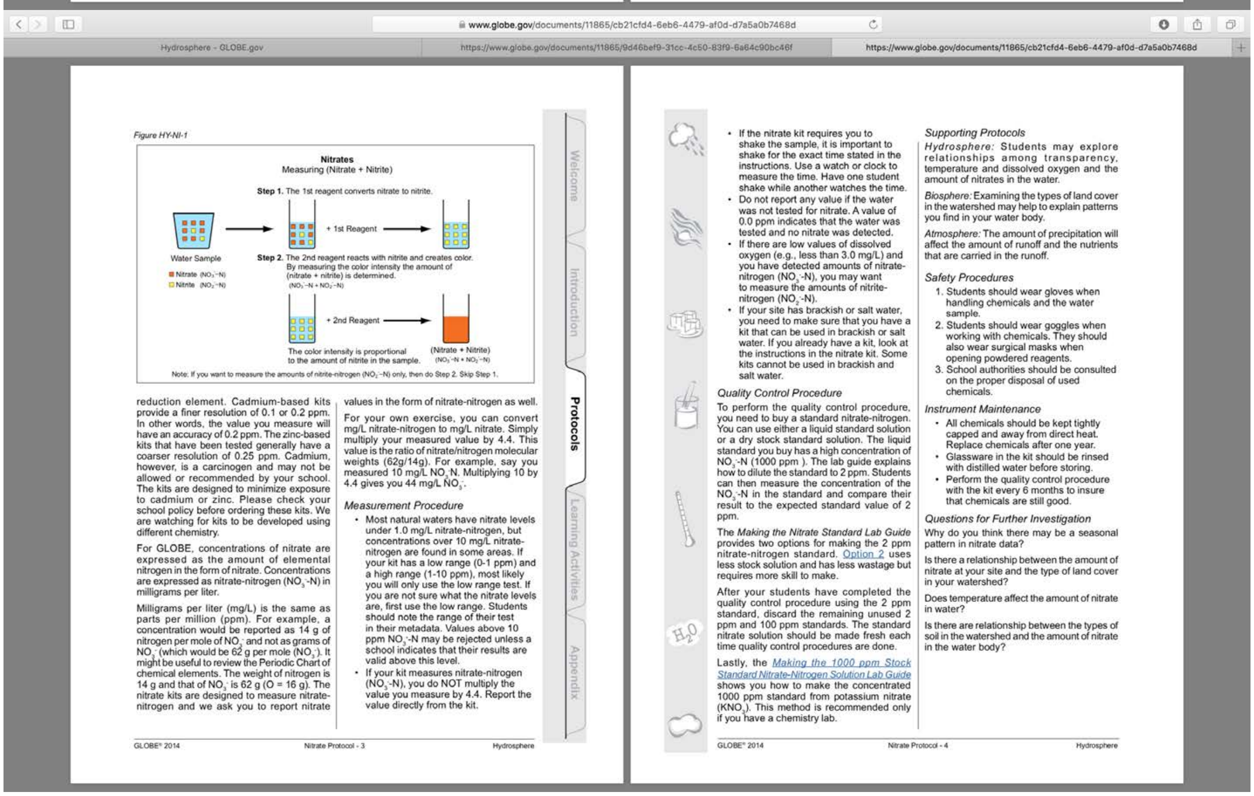
Water Sampling (pdf)
Students will first measure water transparency at their undisturbed study site using a transparency tube or Secchi disk.

Field Guides

Step-by-step instructions for collection data according to the protocols.

Collecting a Water Sample in a Bucket Field Guide (pdf)





The GLOBE nitrate protocol can be found:
https://www.globe.gov/documents/11865/354449/Nitrate+Protocol/cb21cfd4-6eb6-4479-af0d-d7a5a0b7468d

Conclusion and overview of linkages to next lesson and unit goals.

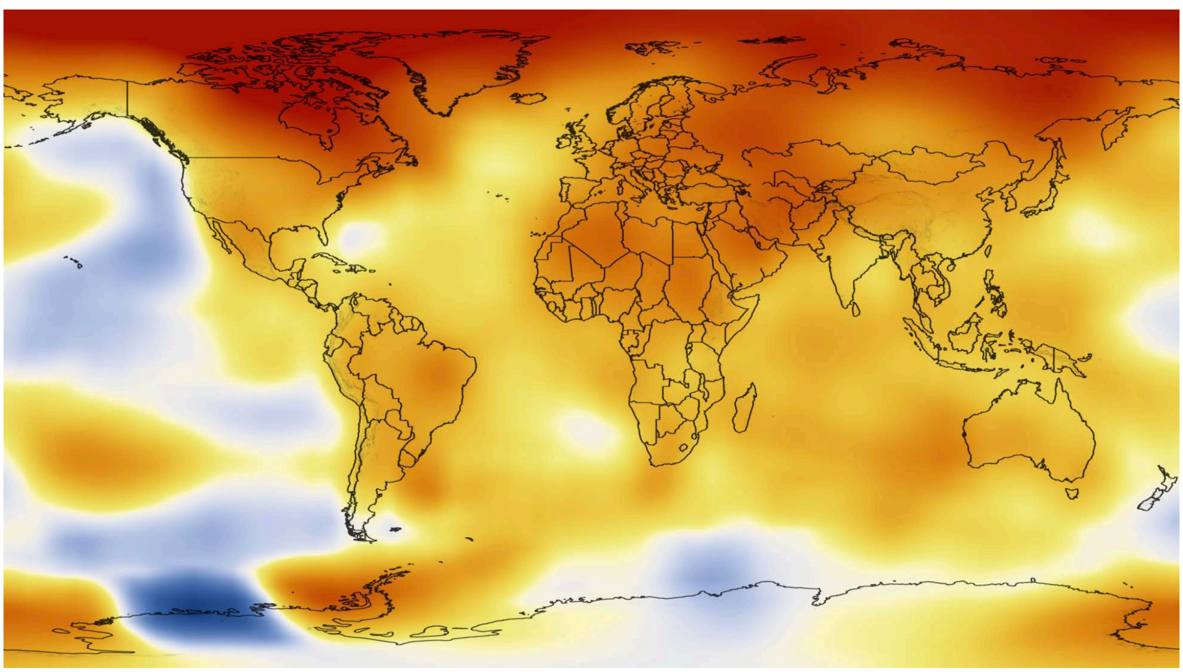
Students now see firsthand the ecological services that saltmarshes provide through their biodiversity, water filtration abilities, and ability to sequester carbon. By running water quality tests, students can also see the variance in water quality by location and learn and implement GLOBE protocols. This then leads into the next lesson where students complete a literature review on how susceptible marshes are to human impact and destruction.

National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Goddard Institute for Space Studies (GISS)
Climate Change Research Initiative (CCRI)
Applied Research STEM Curriculum Portfolio

Unit Title: The Wetlands

Lesson Title: Human Impact on the Wetlands: A literature review
NASA STEM Educator / Associate Researcher: Carol Wang-Mondaca
NASA PI / Mentor: Dr. Dorothy Peet
NASA GSFC Office of STEM Engagement –160



X. Lesson 3: Title Human Impact on the Wetlands: A literature review

a. Summary and Goals of Lesson
   Students, working in groups will be assigned one of seven primary research articles done by NASA scientists on wetlands in a variety of subareas, such as sea level rise, land subsidence, sediment change, and the decreasing levels of biodiversity. Students will be charged with reading, analyzing and summing up the findings in the research article. Each group will then create a PowerPoint presentation to turnkey the findings and analysis to the rest of the class. The goal of this lesson is for each group to become an expert in one article but have a comprehensive understanding of all articles by the completion of the presentations.
b. Table of Contents for lesson

Lesson Title: Human impact on the Wetlands: A literature review
Grade Level: 11th and 12th grade
Duration: one week

	What the Teacher Does	What the Students Do	Duration
Engage: **Pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.**	Models how to complete a review of a scientific article. Supplies students with the science briefs from NASA ([NASA SCIENCE BRIEFS](https://www.giss.nasa.gov/research/briefs/)) (https://www.giss.nasa.gov/research/briefs/) on one of 6-7 articles. One article per group. Article will be truncated so that the abstract, introduction and conclusion are highlighted and therefore more accessible to students at all levels.	Read and annotate the science brief, noting who the researcher is, and possibly doing some background investigation on the researcher.	15 minutes

Explore: **The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.**	Allow students to read the actual science article. Students are encouraged to search up supporting resources to help them understand the article.	Students read, analyze and annotate the article for HW	2 hours (HW)
Explain: **Provide students with an opportunity to communicate what they have learned so far and figure out what it means. EXPLAIN**	Students are instructed to write a review on the article	Students review the article and develop a Power Point presentation Students must be able to explain the rationale behind the research, background information, a sketch of the methods, as well as explain the data collected.	1.5 hours

Elaborate / Extend: **allow students to use their new knowledge and continue to explore its implications.**	Instruct students that they are now the experts in the article and must present	Students will present their presentations to the class and must be able to field questions. Students must be able to cite additional sources that helped them understand the articles Students must be able to relate the article to our current topic.	2 hours

Evaluate: **Both students and teachers to determine how much learning and understanding has taken place.**	Teacher evaluates written review, evaluates PPT presentation, asks questions during presentation, and makes notes of student questions (rubric available)	Students will conduct a peer evaluation of each other PowerPoint presentation. They must provide feedback to their peers and offer constructive criticism. (+/-) Students must note strengths and weaknesses and presentations.	1 hour

c. Content template:

NGSS Standards & NYS Standards: HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. HS-ESS3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on State Science Content Standard: LE 5.1, 6.1, 6.2, 6.3, 7.1, 7.2		Common Core Standard: RST.11.12; HSS.IC.A.2 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.		NASA Science: Earth Science
Content Area: Environmental Science Grade Level:11 & 12 grade	Name of Project-Based Activity or Theme: Literature review of current research of wetlands, sea level changes, climate changes. Students will then present their findings in a powerpoint presentation.		Estimated Time Frame to Complete(days/weeks): 7 days	
Overall Investigation Question(s): How can we read, analyze and present current research on wetlands and human impact, including sea level change and climate change.				
Overall Project Description/Activity: Visit Alley Pond Park, a saltmarsh and survey flora and fauna that are native to the saltmarsh.				
	:			
Materials Needed to Complete Project (put N/A as needed). Selected scientific articles (selected by teacher) Laptops for powerpoint presentation	Stakeholders: Students, teacher, administrator, Alley Pond personnel	Hyperlinks Used: https://zslpublications.onlinelibrary.wiley.com/doi/pdf/10.1002/rse2.105 https://pubs.giss.nasa.gov/docs/2001/2001_Gornitz_go08000d.pdf https://link.springer.com/article/10.1007%2Fs13157-013-0483-0 https://iopscience.iop.org/article/10.1088/1748-9326/aaf0de/pdf https://www.dec.ny.gov/docs/fish_marine_pdf/accismjamnyc.pdf	Multimedia/Technology: Laptops with PPT	Classroom Equipment: Laptops
Analysis of research articles as a team and presentation of literature to the class, making use f=of the illustrations and being able to explain the articles, including methods and results			Smartboard, computer	smartboard
NASA System Engineering	Category (must	Activities	Student Outcomes	Evaluation

Behaviors (2 behaviors per category)	have one Technical Acumen)	How will student model engineering behaviors when learning science content? Describe student activities here.	How will you assess learning for each behavior	Describe specific science content students understand as a result of engineering behavior.
Uses visuals to communicate complex interaction	Communications	Students will have to present complex primary literature in an understandable form to their peers and explain data and imaging.	Works cooperatively with team mates to present literature in an understandable form	
Communicates effectively through personal interaction	Communications	Students will need to work in teams to dissect their article and then present it. Students need to come to a consensus on what is appropriate to include and how to present the materials	Completes the powerpoint/literature review assignment successfully with group members	
Builds Team Cohesion	Leadership	Students must work together and be able to delegate responsibilities and rely on each other to complete tasks	The presentation demonstrates equal division of work and participation	
Appreciates/Recognizes Others	Leadership	The team aspect of the activity helps students recognize others and the information they offer	The students will be able to handle the Q&A sessions with their peers, each person being an active participant. Perhaps each student will be an "expert" at particular points	
Has a comprehensive view	Attitudes & Attributes	While students will most likely divide up the work, each must have a comprehensive understanding of the assignment	The students will be able to handle the Q&A sessions with their peers, each person being an active participant.	
Seeks information and uses the art of questioning	Attitudes & Attributes	The students should be utilizing other resources, handouts and each other as information sources	Utilizes the resources given and also uses internet searches to help each other	
Validates facts, information and assumptions	Systems Thinking	In finding supporting articles and resources, students must validate information and distinguish between evidence based statements and unsupported ones.	Is willing to adjust answers and identifications as new information rises	
Keeps the focus on mission requirements	Systems Thinking	Must focus on meeting deadlines and completion of project	Stays on task	
Learns from success and failures	Technical Acumen	Teacher will provide feedback as the project progresses and students must be willing and able to adjust.	Is willing to adjust answers	
List and attach all supportive documents for instructional activities	Attachments? (circle) Yes or No	List Attached Documents(if any): Primary research articles 1) David Lagomasino et al 2019 *Environ. Res. Lett.* 14 025002 2) Rahman et al 2019 Improved assessment of mangrove forests in Sundarbans East Wildlife Sanctuary using WorldView 2 and TanDEM-X high resolution imagery. *Remote sensing in ecology and conservation*. 3) Gornitz, V., S. Couch, and E.K. Hartig, 2001: Impacts of sea level rise in the New York City		

		metropolitan area. *Glob. Planet. Change*, **32**, 61-88, doi:10.1016/S0921-8181(01)00150-3. 4) Hartig 2002. Anthropogenic and climate-change impacts on salt marshes of Jamica Bay, New York City. Wetlands, 22, 71-89. 5) Gornitz. Enhancing New York City's resilience to sea level rise and increased coastal flooding 6) Fuller, D.O. & Wang, Y. *Wetlands* (2014) 34: 67. https://doi.org/10.1007/s13157-013-0483-0 7) James R Holmquist et al 2018 Environ. Res. Lett. 13 115005		
List and attach all rubrics for activity and assessment evaluation	Attachments? (circle) Yes or No	List Attached Rubrics (if any): Article review/summary rubric Presentation rubric		
Include comments or questions here:				

Literature review instructions

A. You will select one of the following research articles. Keep in mind you will be grouped by your article selection.

Primary research articles

1) David Lagomasino et al 2019 Measuring mangrove carbon loss and gain in deltas *Environ. Res. Lett.* 14 025002
2) Rahman et al 2019 Improved assessment of mangrove forests in Sundarbans East Wildlife Sanctuary using WorldView 2 and TanDEM-X high resolution imagery. *Remote sensing in ecology and conservation*.
3) Gornitz, V., S. Couch, and E.K. Hartig, 2001: Impacts of sea level rise in the New York City metropolitan area. *Glob. Planet. Change*, **32**, 61-88, doi:10.1016/S0921-8181(01)00150-3.
4) Hartig 2002. Anthropogenic and climate-change impacts on salt marshes of Jamica Bay, New York City. Wetlands, 22, 71-89.
5) Gornitz. Enhancing New York City's resilience to sea level rise and increased coastal flooding 2018
6) Fuller, D.O. & Wang, Y. Recent Trends in Satellite Vegetation Index Observations Indicate Decreasing Vegetation Biomass in the Southeastern Saline Everglades Wetlands. *Wetlands* (2014) 34: 67. https://doi.org/10.1007/s13157-013-0483-0
7) James R Holmquist et al 2018 Uncertainty in United States coastal wetland greenhouse gas inventorying. Environ. Res. Lett. 13 115005

B. You will read and annotate the article as we did in class with Dr. Peteet's article, Sediment starvation destroys New York City's marsh resistance to sea level rise. You will follow the same format in providing:
   1. Conduct background research on the article
   2. Describe the materials and methods that were used
   3. Explain the findings, including any data and analysis
   4. Describe the authors' conclusions.
   5. Your paper must be a group effort, formatted properly

C. Finally, you will develop a PowerPoint presentation based on the paper
   1. You will present to the class
   2. You must include data tables, graphs, illustrations, etc. from the paper
   3. You will be prepared to explain the paper as well the findings and implications.

Literature review & PowerPoint Presentation rubric

Item *(numbers in parenthesis indicate points available)*	**Points allotted**	**Points earned**
1. Students must provide background information on their article. a. How does it apply to what we are learning now? (7) b. What is the rationale for the research? (6) c. What background information do the authors discuss? (7)	20	
2. Briefly describe the methods of the research. a. What steps did the researchers follow? (4) b. Was there any special equipment they used? (2) c. What locations did they go to? (4)	10	
3. What were the results? a. Use the illustrations, graphs and tables as part of your explanation i. Inclusion of graphics, graphs, tables (10) ii. Explanation of graphs and tables (10)	20	
4. Analysis and Conclusions a. What conclusions did the researchers draw? (10) b. What were some unanswered questions if any? (5) c. What are the researchers next steps? (5)	20	
5. Students participated equally in the presentation, both in design and during the in-class participation a. Attendance (5) b. Actual in class participation in presentation (5) c. In class design of presentation (5)	15	
6. Students cited additional sources to support their understanding of the topic a. Proper citation is used (5) b. All sources are listed (5)	10	
7. Students proofread and checked their grammar, in their paper and in their presentation.	5	

TOTAL POINTS: ___________

Additional Comments

Differentiated instruction activities

- Students are grouped heterogeneously based on reading and writing levels
- Students are assigned different levels of reading
- Presentation of information is multimodal and heavily supplemented with illustrations
- Students are asked a range of questions, representing lower and higher level questions (What, why, how?)
- Students are working at different speeds and at different levels on what they can understand. Materials are supplemented with the snapshots/summaries from NASA's website.
- Students will be able to take on different roles in the group when presenting the research paper

Discussion prompts

- What is the significance of each study?
- How are they each related—use a concept map to link them.

Discussion prompts~ possible answers

- **What is the significance of each study?**
    - *Sample answers include:*
        - Lagomasino article
            - Mangrove forests resources are in high demand and there has been a steady decline over the years. This study uses temporal and remote sensing to quantify the magnitude and change of carbon stocks. Natural dynamics of erosion and sedimentation impact carbon loss and sequestration of mangrove forests.
        - Rahman article
            - Recent developments in remote sensing techniques can show a more representative view of the landscape because it provides both structure and function of the ecosystem.
        - Gornitz 2001 article
            - Surveys sea level rise in NYC and projects sea level rise in coming years based on a suite of climate change scenarios. Local saltmarshes will not be able to keep up with sea level rise
        - Hartig article

        - Field studies and aerial images suggest that large section of marshes in NYC are deteriorating, due to a variety of reasons, such as dredging, reduced sediment input, boat traffic and sea level rise. Under current conditions, marshes will not be able to keep pace with sea level rise.
    - Gornitz 2018 article
        - The New York City region is subject to higher than average sea level rise due to increase thermal expansion, increase ice losses from ice sheets.
    - Fuller
        - This article analyzed trends in time series of the normalized difference vegetation index (NDVI) from multi-temporal satellite imagery for 2001-2010 over the Southern Everglades. The results suggest that as a results of saltwater intrusion resulting from sea level rise continues to reduce the biomass of the marshes.
    - Holmquist
        - While wetlands are carbons sinks, its degradation can lead to carbon being released. This article looks at the challenges of attempting to inventory carbon in wetlands.

- **How are they each related—use a concept map to link them.** The central "bubble" in this concept map that links all the articles might consist of several concepts, such as saltmarsh loss, importance of wetlands, sea level rise, studies using trends and satellite imaging, and climate change.

Conclusion and overview of linkages to next lesson and unit goals.

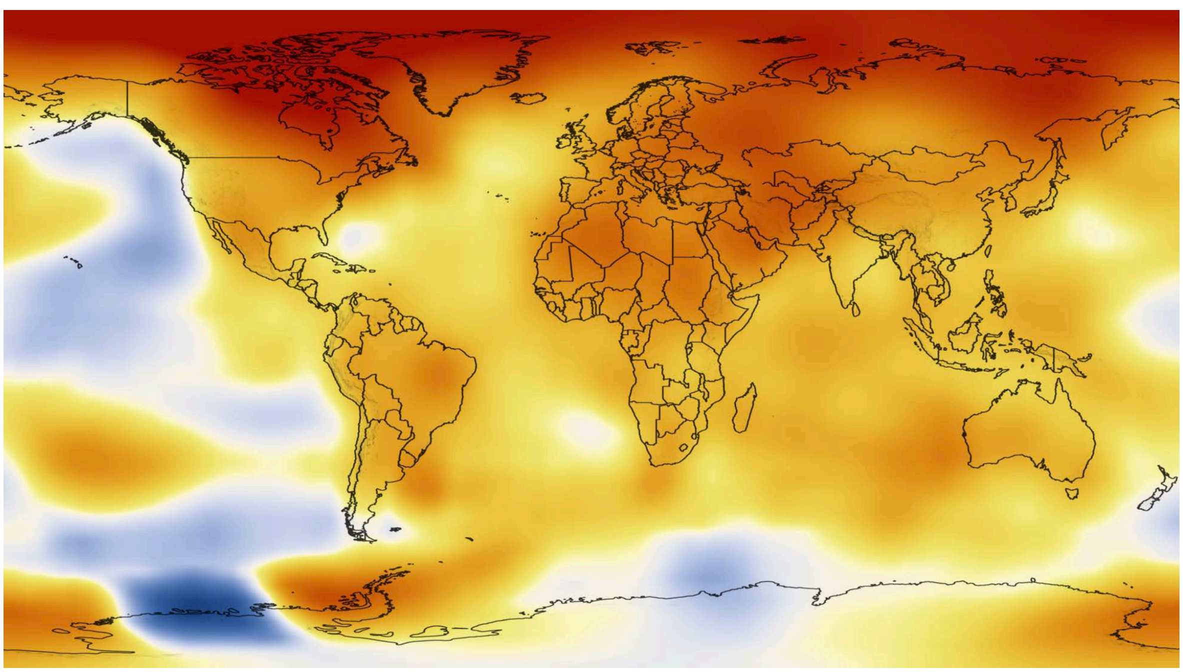
Students complete a literature review on a variety of articles and present them to the class in understandable terms. They focus on actual literature and studies that have been completed and what the current data exists in the field. Students then move into the next lesson where we focus on the research that the CCRI team is working on for Climate Change in the Hudson Estuary. They will have the opportunity to speak to an actual scientist.

National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Goddard Institute for Space Studies (GISS)
Climate Change Research Initiative (CCRI)
Applied Research STEM Curriculum Portfolio

Unit Title: Wetlands

Lesson Title: Why preserve wetlands
NASA STEM Educator / Associate Researcher: Carol Wang-Mondaca
NASA PI / Mentor: Dr. Dorothy Peteet
NASA GSFC Office of STEM Engagement –160



XI. Lesson 4: Title Why preserve wetlands?

a. Summary and Goals of Lesson

Students will learn about Dr. Peteet's current research and gain an understanding of the information we can gain from coring. They will get a basic understanding of the techniques and principles behind coring. They will learn about loss on ignition calculations as well as formanifera and macrofossil composition of saltmarshes. Students will the develop their own methodology and protocols to simulate the core retrieving and analysis process. We will be videoconferencing twice with Dr. Peteet so that students have (1) an opportunity to ask her questions after I present our research and then again (2) after they've developed their protocols to receive constructive feedback from Dr. Peteet. Alternatives—another Goddard Scientist. Teachers can also learn of Dr. Peteet's work through the NatGeo video " Students Kill Invasive Phrag (https://www.giss.nasa.gov/research/briefs/)
."

b. Table of Contents for lesson

Lesson Title: Why preserve the wetlands: designing a coring expedition.
Grade Level: 11th and 12th graders
Duration: one week

	What the Teacher Does	What the Students Do	Duration
Engage: **Pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.**	Present the research done during the CCRI teams' time together **Video conference in Dr. Peteet ** Alternative: show the video on Dr. Peteet's work through the NatGeo video " Students Kill Invasive Phrag. (https://www.giss.nasa.gov/research/briefs/)" Show video on saltmarsh coring (https://www.youtube.com/watch?v=1_770uqsS2Y) , saltmarsh coring Rutgers (https://www.youtube.com/watch?v=pEErKoDChZM)	Take notes **Develop questions for Dr. Peteet, biographical and regarding her research.	45 minutes 45 minutes
Explore: **The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.**	Ask students to explore how we as a class can do the same. Elicit suggestions to core at Alley Pond saltmarsh.	Brainstorm ways to collect soil samples and to core (using household tools perhaps and keeping in mind budgetary constraints. Students should also ask what else can be tested given our lesson on water testing.	1 hour

Explain: **Provide students with an opportunity to communicate what they have learned so far and figure out what it means. EXPLAIN**	Instruct students to develop materials and methods/procedures.	Students will develop the materials and methods protocol as suitable for the classroom, drawing on what they've learned in class Students come to one consensus on a class protocol to core, including map assignments for each group	1 hour
Elaborate / Extend: **allow students to use their new knowledge and continue to explore its implications.**	Plan a trip to Alley Pond for coring Provide a map of the saltmarsh at Alley.	Students will decide on different areas of the marsh to core. Include materials and protocol for including locating and identifying saltmarsh species. Include materials	1 hour

		and protocols for water testing.	
Evaluate: **Both students and teachers to determine how much learning and understanding has taken place.**	Teacher evaluates project plan as well as the role each student has. Teacher will arrange video conference #2 with Dr. Peteet.	Students share out their plan with other groups. Revise and revisit to create one class plan. Share out project plan with Dr. Peteet and receive feedback on their protocols. Students will be prepared to explain their methods and procedures and be receptive to	1 hour

		constructive criticism.	

c. Content template:

NGSS Standards & NYS Standards:	Common Core Standard: RST.11.12; HSS.IC.A.2	NASA Science:
HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. HS-ESS3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1),(HS- LS2-2),(HS-LS2-3) **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3) **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)	Earth Science

Content Area: Environmental Science Grade Level:11 & 12 grade	Name of Project-Based Activity or Theme: Developing the Plan: Coring in Alley Pond Saltmarsh		Estimated Time Frame to Complete(days/weeks): 5-6 days	

Overall Investigation Question(s): How do we develop an experimental plan for the retrieval of cores from Alley Pond Saltmarsh?				
Overall Project Description/Activity: Students will get a preview of our CCRI team's project on the Hudson Estuary				
	:			
Materials Needed to Complete Project (put N/A as needed). Laptops	Stakeholders: Students, teacher, administrator, Alley Pond personnel	Hyperlinks Used: The vanishing marshes at Jamaica Bay https://www.giss.nasa.gov/research/briefs/hartig_01/ https://earthengine.google.com/case_studies/ Tools of the trade: a peek inside the bog-coring lab of Dorothy Peteet https://blogs.ei.columbia.edu/2018/12/19/tools-bog-coring-peteet/ www.GLOBE.gov	Multimedia/Technology: Laptops so that students can collaborate on working out their plan Video conference with Dr Peteet—internet connection, smartboard and speakers.	Classroom Equipment: Laptops
NASA System Engineering Behaviors (2 behaviors per category)	Category (must have one Technical Acumen)	Activities How will student model engineering behaviors when learning science content? Describe student activities here.	Student Outcomes How will you assess learning for each behavior	Evaluation Describe specific science content students understand as a result of engineering behavior.
Ensures system integrity	Leadership	Students will be processing their samples and collecting data. Even if errors are made, which are inevitable, students must be willing to note them	Students will conduct an error analysis, including human errors, and devise plans for the future.	Students must include erroneous data and any errors that are made.
Appreciates/Recognizes Others	Leadership	Students assist each other in the lab and in the field	Students keep an organized and clean lab for students who come in after their class	Student maintain an organized and clean lab area without having to be instructed
Communicates effectively through personal interaction	Communications	Students must form a cohesive unit to complete the lab tasks, including baking and taking weight measurements. Students consult with each other to determine foram and macrofossil species ID	Students will be able to work as a unit to follow lab protocols.	The students must all be able to speak to their role in the lab and what is being done and why.
Listens effectively and translates information	Communication	Students follow lab protocols and are able to follow both verbal and written instructions to process their samples and take weight measurements and calculate LOI	Students follow protocol and calculate their data correctly	Students are able to calculate their data and explain how they arrived at their analysis.
Advances ideas	Attitudes & Attributes	Students need to work together to determine the best way to retrieve their core and the materials to do it.	How effective are the students' game plan?	Students need to understand that a vertical segment of core is needed that is intact and undisturbed and from various areas aro9und the wetland.
Seeks information and uses the art of questioning	Attitudes & Attributes	Students need to ask questions about where to core and why.	Students are able to find a variety of locations to retrieve core samples	Students are able to compare and contrast data from different groups and ask why data is similar or different.
Validates facts, information and assumptions	Systems Thinking	Students utilize the background information grounded in primary research articles.	Students support their findings with science and fact.	Students cite primary literature and appropriate, reliable

				sources.
Keeps the focus on mission requirements	Systems Thinking	Students need to complete their lab work	All students are actively participating to complete the checkpoints of the lab, whether they are baking or weighing the samples.	Students complete the lab checkpoints and keep a log of what has been completed.
Learns from success and failures	Technical Acumen	Students will be processing their samples and collecting data. Even if errors are made, which are inevitable, students must be willing to note them	Students will conduct an error analysis, including human errors, and devise plans for the future.	Students must include erroneous data and any errors that are made.
List and attach all supportive documents for instructional activities GLOBE Water and soil testing protocols	Attachments? (circle) Yes or No			
List and attach all rubrics for activity and assessment evaluation	Attachments? (circle) Yes or No	List Attached Rubrics (if any): Article review/summary rubric Presentation rubric		
Include comments or questions here:				

Coring at Alley Pond Saltmarsh: Project Plan Development

Create a research plan based on how the CCRI team completed coring to conduct your own coring at Alley Pond Park.

You must:

Develop the materials and

1) methods. Include all materials you will need. Keep in mind our budget. You may be creative in your selection of materials or adjustment/modification of existing materials, such as household items.
2) You must include safety protocols in your outline, especially since we will be in water saturated areas with slippery areas near bodies of water that may not have easily accessible access points.
3) As you develop your plan, keep in mind the specific data we will want to collect, on site, as well as in the lab after we bring samples back. (On site data collection might include simple items such as weather, tide level, cloud cover, and location). You should also be noting what kind of observations you will be making.

4) You must also think about the location where you want to collect your core. (should include observations while we are onsite regarding your core site).
5) As you develop your materials, think about the process of transporting our equipment to the site, the collection process, as well as bringing the samples back to the lab for storage until we are ready to work with and analyze the samples.
6) Your team must work together and take equal ownership of the plan. Pick your team mates carefully.

Plan Category	Draft	Revision
1. Materials Include materials that need to be made or purchased (keep in mind our budget) 		
2. Methods Include location, safety protocols. Think about what you want to test and why 		

Plan Category	Draft	Revision
3. Data to be collected (includes data @ the site as well as data that will be collected in the lab)  *Other notes:*		
4. Observations to be made (site observations such as location of your site and vicinity to sewage overflow, human industry, etc., weather, any wetland species you might see, etc.)  *Other notes:*		

Plan Category	Draft	Revision
5. Potential Challenges (don't forget to address those challenges with possible solutions/alternatives)  *Other notes:*		

Differentiated instruction activities

- Students are grouped heterogeneously based on reading and writing levels
- Students are assigned different levels of reading
- Presentation of information is multimodal and heavily supplemented with illustrations
- Students are asked a range of questions, representing lower and higher level questions (What, why, how?)
- Students are working at different speeds and at different levels on what they can understand.
- Students will be able to take on different roles in the group when presenting the research paper

Discussion prompts

- Why do protocols require constant revision?
- How do we address potential challenges?
- How do we reach one protocol?

Discussion prompts~ suggested answers

- Why do protocols require constant revision?
  We need to add or remove items depending on the need. For example, we may find that safety protocols need to be more specific and address more items. We can decide that water testing protocols need to be more specific and that more detailed instructions need to be outlined. Another example might be that equipment needs to be calibrated more often if there are more groups using the same equipment.
- How do we address potential challenges?
  We can look for possible solutions or alternatives. For example, if there is a water source we cannot reach safely, we can change the location. Sometimes, we may find that we need more time for certain tasks and will have to adjust our schedule.
- How do we reach one protocol?
  In order to reach a consensus, we need to outline what each group has and create one list that we can all agree on. We can vote on which protocols we think must be included and also on what is unnecessary to include.

Conclusion and overview of linkages to next lesson and unit goals.

By designing their protocols and methods, students have a greater stake in the experiment. They will also learn the process of revising and adjusting their methodology. This leads directly into executing their plan to begin their experiment of coring.

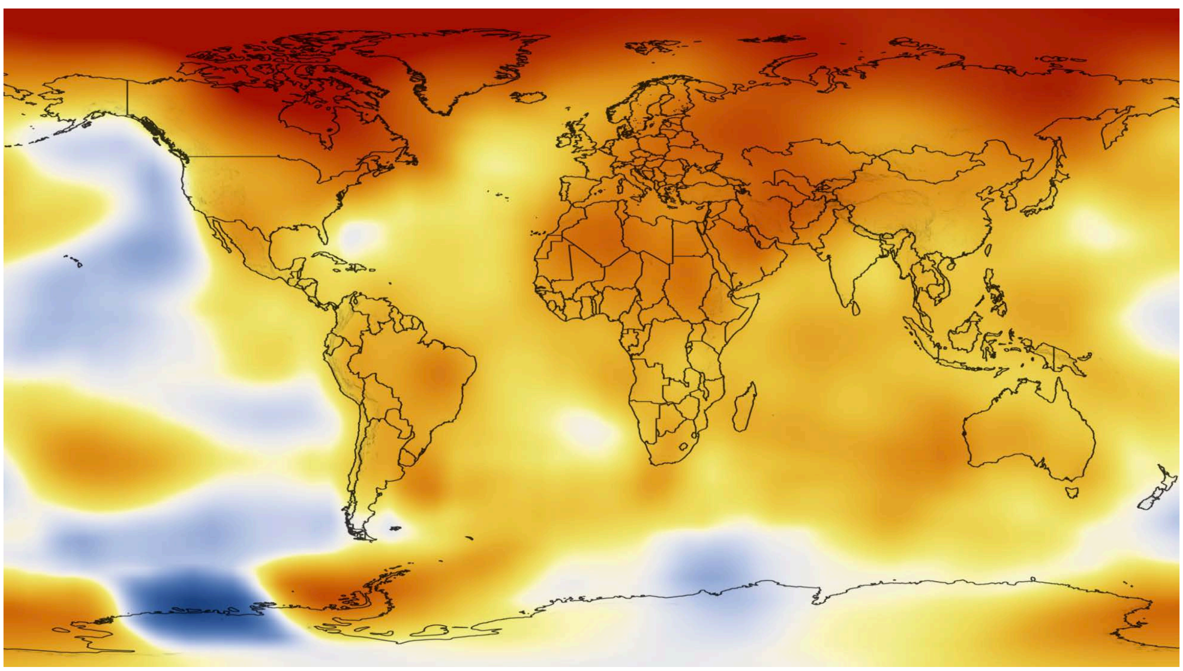
National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Goddard Institute for Space Studies (GISS)
Climate Change Research Initiative (CCRI)
Applied Research STEM Curriculum Portfolio

Unit Title: The Wetlands

Lesson Title: Coring at Alley Pond Saltmarsh
NASA STEM Educator / Associate Researcher: Carol Wang-Mondaca
NASA PI / Mentor: Dr. Dorothy Peteet

NASA GSFC Office of STEM Engagement –160



XII. Lesson 5: Coring at Alley Pond Saltmarsh

a. Summary and Goals of Lesson

Students will be conducting field work at Alley Pond saltmarsh. Using a PCVC pipe, students, working in groups, will core at different areas at the saltmarsh. They only need to go as deep as about 20 inches to observe differences, hopefully. Students will then conduct lab work, selecting samples at very 4 cm. They will conduct loss of ignition procedures, baking in our lab at 100'C. The samples will then be brought to Lamont to complete the baking process at the higher temperature of 600'C. Students will weigh the samples, calculate loss of ignition, analyze the data and draw conclusions. Students will also identify and collect samplings of macrofossils and foramnifera to determine the composition/profile at each core segment.

b. Table of Contents for lesson

Lesson Title: Coring at Alley Pond Saltmarsh
Grade Level: 11th and 12th graders
Duration: 2 weeks.

	What the Teacher Does	What the Students Do	Duration
Engage: **Pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.**	Provide suggestions	Core a) Follow materials/methods to perform coring at Alley b) Visit Alley c) Collect core samples d) Collect water samples	

Explore: **The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.**	Teacher supplies the students with guidance and instruction	Students will follow their protocol to collect the segments of core and process them (baking, weighing, recording data). Students will also process the core for forams and macros. Students will lead the labs.	
Explain: **Provide students with an opportunity to communicate what they have learned so far and figure out what it means. EXPLAIN**	Teacher asks students to present their data (in graphs and tables).	Students will collect and analyze data. They will present the data.	
Elaborate / Extend: **allow students to use their new knowledge and continue to explore its implications.**	Teacher asks students to draw conclusions.	Students must draw conclusions and write up their lab report. Students will determine if there are any patterns and draw conclusions based on their data. Students will upload their data to GLOBE	

Evaluate: **Both students and teachers to determine how much learning and understanding has taken place.**	Teacher will evaluate student peer reviews as well as the labs themselves. Teacher will evaluate students' development of materials and methods, their data collection process as well as their data analysis.	Students will peer review lab reports and offer feedback. Students will come up with a plan on how to alleviate the effects of human impact on Alley Pond.	

c. Content template:

NGSS Standards & NYS Standards:	Common Core Standard: RST.11.12; HSS.IC.A.2	NASA Science:
HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. HS-ESS3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1),(HS- LS2-2),(HS-LS2-3) **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3) **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)	Earth Science

Content Area: Environmental Science Grade Level:11 & 12 grade	Name of Project-Based Activity or Theme: Coring in Alley Pond Saltmarsh		Estimated Time Frame to Complete(days/weeks): 10 days	
Overall Investigation Question(s): How can the retrieval of cores from Alley Pond Saltmarsh provide us with paleo-ecological information?				

Overall Project Description/Activity: Core at Alley Pond Park using protocols designed by the students. Students will then segment the core in the lab and perform LOI process. Students will then, based on the weight measurements and appropriate calculations, determine LOI and hence organic component of the saltmarsh at various locations. Students will then create a formaniferea and macrofossil profile to determine what kind of flora existed at various times and deduce the changes in the environment from past to present day.				
	:			
Materials Needed to Complete Project (put N/A as needed). PVC pipes Cores from Alley Pond Oven Crucibles Digital balances Calculators Hot gloves Microscopes Paintbrushes Petri dishes	Stakeholders: Students, teacher, administrator, Alley Pond personnel	Hyperlinks Used: The vanishing marshes at Jamaica Bay https://www.giss.nasa.gov/research/briefs/hartig_01/ https://earthengine.google.com/case_studies/ Tools of the trade: a peek inside the bog-coring lab of Dorothy Peteet https://blogs.ei.columbia.edu/2018/12/19/tools-bog-coring-peteet/ www.GLOBE.gov	Multimedia/Technology: Laptops with excel so that students can plot and analyze data using tables and graphs	Classroom Equipment: Laptops PVC pipes Cores from Alley Pond Oven Crucibles Digital balances Calculators Hot gloves Microscopes Paintbrushes Petri dishes
NASA System Engineering Behaviors (2 behaviors per category)	Category (must have one Technical Acumen)	Activities How will student model engineering behaviors when learning science content? Describe student activities here.	Student Outcomes How will you assess learning for each behavior	Evaluation Describe specific science content students understand as a result of engineering behavior.
Ensures system integrity	Leadership	Students will be processing their samples and collecting data. Even if errors are made, which are inevitable, students must be willing to note them	Students will conduct an error analysis, including human errors, and devise plans for the future.	Students must include erroneous data and any errors that are made.
Appreciates/Recognizes Others	Leadership	Students assist each other in the lab and in the field	Students keep an organized and clean lab for students who come in after their class	Student maintain an organized and clean lab area without having to be instructed
Communicates effectively through personal interaction	Communications	Students must form a cohesive unit to complete the lab tasks, including baking and taking weight measurements. Students consult with each other to determine foram and macrofossil species ID	Students will be able to work as a unit to follow lab protocols.	The students must all be able to speak to their role in the lab and what is being done and why.
Listens effectively and translates information	Communication	Students follow lab protocols and are able to follow both verbal and written instructions to process their samples and take weight measurements and calculate LOI	Students follow protocol and calculate their data correctly	Students are able to calculate their data and explain how they arrived at their analysis.
Advances ideas	Attitudes & Attributes	Students need to work together to determine the best way to retrieve their core and the materials to do it.	How effective are the students' game plan?	Students need to understand that a vertical segment of core is needed that is intact and undisturbed and from various areas aro9und the wetland.
Seeks information and uses the art of questioning	Attitudes & Attributes	Students need to ask questions about where to core and why.	Students are able to find a variety of locations to retrieve core samples	Students are able to compare and contrast data from different groups and ask why data is similar or different.
Validates facts, information and assumptions	Systems Thinking	Students utilize the background information grounded in primary research articles.	Students support their findings with science and fact.	Students cite primary literature and appropriate, reliable

				sources.
Keeps the focus on mission requirements	Systems Thinking	Students need to complete their lab work	All students are actively participating to complete the checkpoints of the lab, whether they are baking or weighing the samples.	Students complete the lab checkpoints and keep a log of what has been completed.
Learns from success and failures	Technical Acumen	Students will be processing their samples and collecting data. Even if errors are made, which are inevitable, students must be willing to note them	Students will conduct an error analysis, including human errors, and devise plans for the future.	Students must include erroneous data and any errors that are made.
List and attach all supportive documents for instructional activities GLOBE Water and soil testing protocols	Attachments? (circle) Yes or No			
List and attach all rubrics for activity and assessment evaluation	Attachments? (circle) Yes or No	List Attached Rubrics (if any): Article review/summary rubric Presentation rubric		
Include comments or questions here:				

Coring at Alley Pond Saltmarsh
Data Collection & Analysis

You must use your science lab notebook for all maps, sketches, notes and data tables. You must use your science notebook to collect the following data and represent the data in an organized fashion, whether it be tables or graphs or both. You may transfer everything to an electronic form afterwards, but your initial data collection must be in your notebooks.

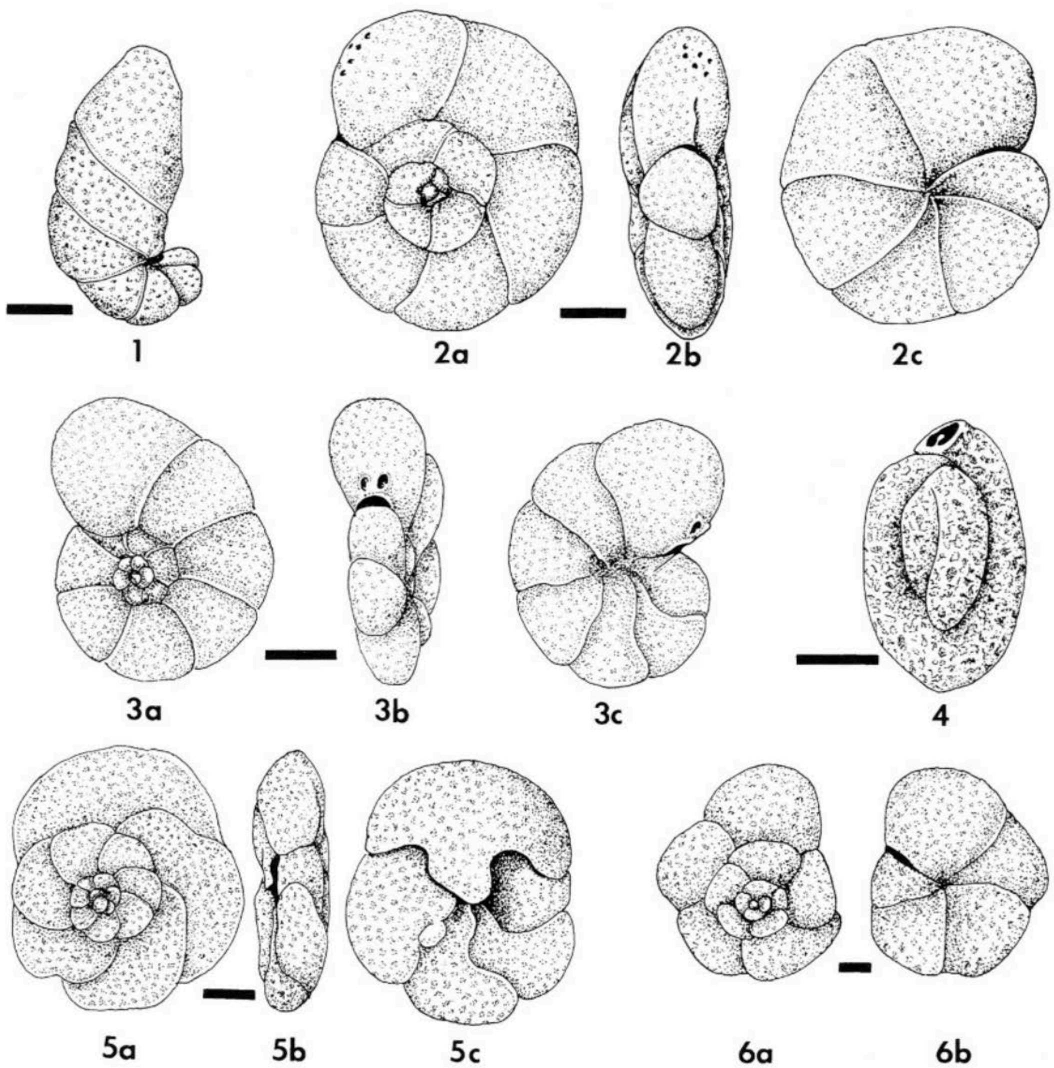
A sample of the kinds of sketches, observation, data tables, etc are below:

1) Map your location (make sure to annotate any urban areas, sewage overflow areas, bodies of water, forest covers, etc.
2) Take notes of what kinds of saltmarsh plants and animals you encounter. Don't forget to look up into the trees and down low in the soil and in the water.
3) Make note of weather, cloud cover, and other environmental conditions
4) Core collection and data analysis. You must graph your data (which is your x-axis and which is your y-axis?)

depth (cm)	Crucible (mass in grams) A	Crucible + Sample (Wet) B	Wet Weight (B-A)	100"C Crucible + Sample C	Dry Weight C-A	600'C Crucible + Sample D	600'C Weight D-A	Weight Loss E (C-A)-(D-A)	Loss on Ignition (LOI) (E/C-A)	% organic	% inorganic
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

5) Formanifera (specify genus and species in each column, Use tally marks to note how many of each you find). Use the illustrations below to help you (from Gupta, 1990).

depth (cm)	**Foram A:** genus + species example: *Trochommina mexicana*	**Foram B:** *genus + species*	**Foram C:** *genus + species*	**Foram D:** *genus + species*
0-4	IIII			
4-8				
8-12				
12-16				
16-20				



1 2a 2b 2c
3a 3b 3c 4
5a 5b 5c 6a 6b

Figure 9.2 Widespread agglutinated Foraminifera of salt marshes: 1, *Ammotium salsum* (Cushman and Brönnimann); 2a,b,c, *Arenoparrella mexicana* (Kornfeld), dorsal, edge, and ventral views; 3a,b,c, *Jadammina macrescens* (Brady), dorsal, edge, and ventral views; 4, *Miliammina fusca* (Brady); 5a,b,c, *Tipotrocha comprimata* (Cushman and Brönnimann), dorsal, edge, and ventral views; 6a,b, *Trochammina inflata* (Montagu). Scale bars = 0.1 mm. Redrawn from Brady, 1884 (6); Cushman and Brönnimann, 1948 (1); Saunders, 1958 (2, 4, 5); and Haynes, 1973 (3).

6) Water quality testing

Factor	**Normal Range:**	**Your reading:**	**What does this mean? (rationale behind the test and what your results mean)**
1.Temperature			
2. pH			
3. Dissolved Oxygen			
4. Nitrates			
5. Phosphates			
6. Total Coliform Bacteria			
7. Turbidity			
8. Total Dissolved solids and salinity			

7) At the end of each day, you must summarize what you did for the day and highlight the data you found and draw any conclusions. You must also outline what each team member did for the day. Then outline plan of action of for the following day. Example:
   a. Day/Date______________
   b. We completed _______________
   c. Observations, conjectures, etc.
   d. Plan of action for tomorrow

Water Quality Testing Rubric

Measurements (part 1—total of 72 points)

2 — measurement taken 1 — measurement taken, no units 0 — no measurements taken	Normal Range (3 points each)	Your Reading (3 points each)	Rationale (3 points each)
1.Temperature			
2. pH			
3. Dissolved Oxygen			
4. Nitrates			
5. Phosphates			
6. Total Coliform Bacteria			
7. Turbidity			
8. Total Dissolved solids and salinity			
TOTAL POINTS	24	24	24

Part 1 Total______

Observations/Plan (Part 2—28 total points)

Category	**Points allotted**	**Points earned**
Observations, conjecture	10	
Plan of action for the following day	10	
Each team member's tasks clearly outlined	8	

Part 2 Total______

Total points earned (Part 1 + Part 2)______________

Discussion Prompts

- What are your findings?
- What conclusions can you draw based on your findings?
- What further research might you have to do?
- What are your next steps?

Discussion Prompts~ suggested answers

- What are your findings?
    - Student answers will vary but should be compared to what is normal for the area. Students may answer in relative terms, such as the water is more or less acidic, the water is colder or warmer than normal, there is less dissolved oxygen, there is a high/low level of nitrates, there is a high level of total coliform bacteria, the water is very salty, etc.
- What conclusions can you draw based on your findings?
    - A higher than normal range of nitrates or phosphates may indicate that there is agricultural run off or pollution, low levels of dissolved oxygen might indicate increase in decomposition, higher than normal level of coliform bacteria may indicate human waste, sewage in the area, low pH ay indicate effects of acid rain.
- What further research might you have to do?
    - Repeat the trial, increase the sampling size by investigating other bodies of water nearby.
- What are your next steps?
    - Draw conclusions based on the data and design a next experiment.

Differentiated instruction activities

- Students are grouped heterogeneously based on reading and writing levels
- Students are assigned different levels of reading
- Presentation of information is multimodal and heavily supplemented with illustrations
- Students are asked a range of questions, representing lower and higher level questions (What, why, how?)
- Students are working at different speeds and at different levels on what they can understand. Materials are supplemented
- Students will be able to take on different roles in the group when working on the lab (data recorder, observer, data analysis, etc).
- Highly interactive lab that incorporates multiple entry points

Coring at Alley Pond Park Salt Marsh
Peer Review Instructions and Rubric

Reviewer Name (your name) ________________________________

Group being reviewed (list names alphabetically)

1.____________________________

2.____________________________

3.____________________________

4.____________________________

Instructions:

1) You will be swapping lab reports with another group. There will be enough copies of the lab so that each person in the group has his/her own copy.
2) It is your responsibility to read and grade the lab using the rubric below and provide constructive feedback.
3) The final grade given will be an average of all the grades from the entire group that is completing the peer review.
4) Keep in mind that you need to provide *actionable* feedback and therefore should be looking for ways that the group could improve on their lab or research protocols in future experiments.

Item	Points allotted	Points earned
1. Students must provide background information on their research. a. How does it apply to what we are learning now? (7 pts) b. What is the rationale for the research? (6 pts) c. Background research is relevant to the current research being conducted (7pts)	20	
2. Students describe the materials and methods of the research. a. What steps did the students follow? (2) b. Was there any special equipment they used or created? (2) c. What locations did they go to? (2) d. Would you be able to follow their methods and protocol? (4)	10	
3. What were the results? a. Students include at least illustrations and/or pictures, include appropriate graphs and tables as part of data section. At least 3 data tables or graphs are included (4 points each) (12) b. Graphs and illustrations are appropriately labeled (3) c. Explanations are provided for every single item(10)	25	
4. Analysis and Conclusions a. What conclusions did the students draw? (10) b. What were some unanswered questions, if any? (5) c. Did students draw on background research to support their analysis and conclusion? (10) d. Did students discuss next steps, possible sources of error, how to improve the experiment? (5)	30	
5. All sources not original to the students are cited (5) Students cited additional sources properly (5).	10	
6. Students proofread and checked their grammar.	5	

TOTAL POINTS: ___________

Additional Comments

XIII. Bibliography APA

A Framework for K–12 Science Education. (n.d.). Retrieved from https://www.nextgenscience.org/framework-k-12-science-education

NASA Strategic Plan 2018. (2018). *NASA Strategic Plan 2018*. Retrieved from https://www.nasa.gov/sites/default/files/atoms/files/nasa_2018_strategic_pl an.pdf.